Supervised Learning for Retinal Disease Classification using Fundus Images

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Academic Project

Abstract

Diabetes can lead to serious complications, including diabetic retinopathy (DR), a leading cause of blindness in individuals under 50.[1] DR occurs when high blood sugar damages retinal blood vessels, leading to swelling, fluid leakage, and vision impairment. Early detection and accurate classification are crucial for timely intervention. This project presents the Gu_CNN model, a lightweight convolutional neural network (CNN) designed to classify the severity of DR. It combines VGG-style convolutional layers for feature extraction, ResNet residual blocks for deep learning, and Squeeze-and-Excitation (SE) attention modules for improved feature recalibration. Trained on the APTOS 2019 Blindness Detection dataset with preprocessing techniques like normalization, data augmentation, and class rebalancing, the model achieved a test accuracy of 89.80% and a macro F1-score of 0.8988. Evaluation using confusion matrix, ROC, and Precision-Recall curves confirmed its robustness. Future work will focus on enhancing generalization and reducing loss to further improve accuracy.

Dataset & Preprocessing

Figure1: The five different Diabetic Retinopathy(DR) stages increase in severity from left to right: no DR, mild DR, moderate DR, severe DR, and proliferative DR.[2]

The dataset[3] contains a large number of retinal images taken using fundus photography under a variety of imaging conditions, and clinicians rated the severity of diabetic retinopathy for each image on a scale of 0 to 4:

0 - no DR, 1 - mild, 2 - moderate, 3 - severe, and 4 - proliferative DR.

The following pictures show the comparison before and after preprocessing:

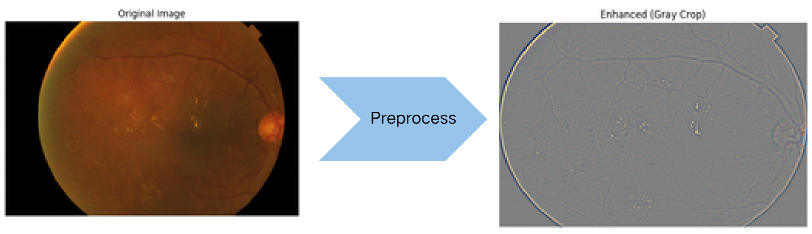


Figure 2: Comparison of image cropping and enhancement results

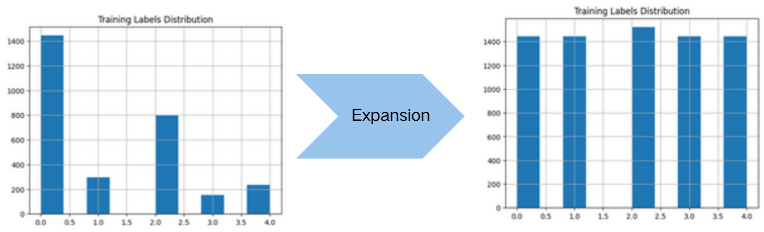


Figure 2: Comparison of dataset distribution before and after expansion

Class	0	1	2	3	4	total
Data	1805	370	999	193	295	3662

Table1: Overview of images from the APTOS 2019 dataset

Model & Deployment

- The model combines the convolutional layer architecture of VGG and the residual layer of ResNet

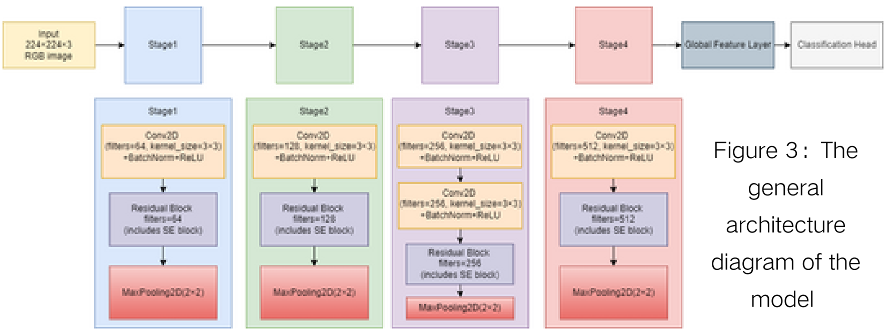


Figure 3: The general architecture diagram of the model

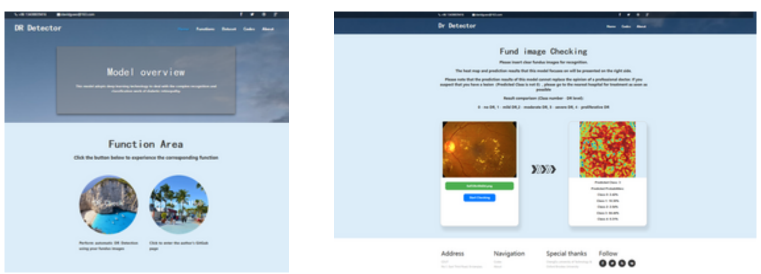


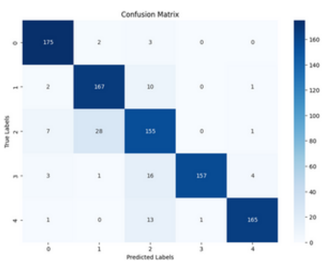
Figure 4: The GUI of DR Check Website

Conclusion, Limitation and Future work

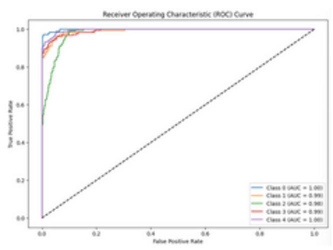
This study proposes a CNN model for diabetic retinopathy (DR) classification, combining VGG and ResNet architectures with squeeze and excite (SE) attention for feature recalibration.It was trained on the APTOS 2019 dataset with 3,662 samples, using preprocessing techniques like image cropping, enhancement, and data augmentation. The model achieved a test accuracy of 89.80%, an F1 score of 0.8988, and an AUC above 0.98 for all categories. The confusion matrix shows strong performance, especially in severe and proliferative DR cases. However, the model's performance is lower for moderate DR due to subtle feature differences and potential overfitting. Using only one dataset limits its ability to generalize across diverse imaging conditions.Future work aims to enhance model performance and adaptability, reduce training costs through self-supervised learning, and improve interpretability for clinical use through explainable AI approaches.

Result

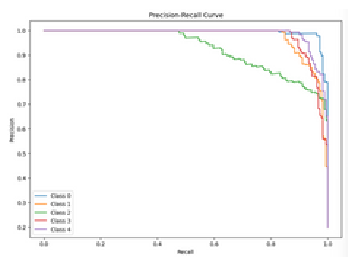
- The training is evaluated with Accuracy, Loss, Precision-Recall, ROC , F1-Score, AUC, ROC, Confusion Matrix.
- A Classification Report is also provided.



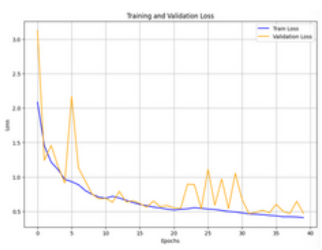
Confusion Matrix



ROC curves



Precision-Recall curves



Loss

Accuracy

	precision	recall	f1-score	support
0	0.93	0.97	0.95	180
1	0.84	0.93	0.88	180
2	0.79	0.81	0.80	191
3	0.99	0.87	0.93	181
4	0.96	0.92	0.94	180
Accuracy			0.90	912
Macro avg	0.90	0.90	0.90	912
Weighted avg	0.90	0.90	0.90	912

Classification Report

Reference

[1] Amin, Javeria, Sharif, Muhammad, Yasmin, Mussarat, A Review on Recent Developments for Detection of Diabetic Retinopathy, Scientifica, 2016, 6838976, 20 pages, 2016. https://doi.org/10.1155/2016/6838976.

[2] Vora, P.; Shrestha, S. Detecting Diabetic Retinopathy Using Embedded Computer Vision. Appl. Sci. 2020, 10, 7274. https://doi.org/10.3390/app10207274

[3] Asia Pacific Tele-Ophthalmology Society (APTOS). APTOS 2019 Blindness Detection. Available at: https://www.kaggle.com/c/aptos2019-blindness-detection/data

GitHub: https://github.com/Blacknomizi/DR-detect EMail: davdiguwx@163.com