AUTOMATED IDENTIFICATION AND SEVERITY GRADING OF DIABETIC RETINOPATHY THROUGH A HYBRID DEEP LEARNING FRAMEWORK

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Abstract

Diabetic retinopathy (DR) is one of the leading causes of visual impairment and blindness around the world, especially for diabetics. The importance of early detection and severity grading of the disease cannot be overstated as it is critical for timely intervention. In this study, the authors propose an automated deep learning system for classification of DR based on the images of the retinal fundus. The images used in this study were taken from the three publicly available datasets: EyePACS, APTOS 2019 Blindness Detection and MESSIDOR. The original dataset consists of 3,554 images belonging to five categories of the severity of DR disease: No DR with 968 images, Mild DR with 527 images, Moderate DR with 395 images, Severe DR with 575 images and Proliferativ DR with 1,089 images. After data balancing, the authors used 2,500 images, 500 per class. The images were resized to 224 x 224 pixels and underwent median filtering, contrast enhancement with the use of Contrast Limited Adaptive Histogram Equalization (CLAHE) and normalization. The process of sampling allowed the authors to divide the dataset into training, validation and testing groups consisting of 70%, 15% and 15% of images respectively. The resulting hybrid architecture represents a combination of DenseNet121 pretrained on ImageNet and InceptionV3 networks by merging the features extracted from the model was optimized through the use of transfer learning and fine-tuning. The obtained results showed 96.8% accuracy, 96.9% precision, 96.8% recall, 96.81% F1-score, 99.2% specificity, and 99.88% AUC-ROC on the test dataset. It was found that the framework outperforms both DenseNet121 and InceptionV3 models based on the reported accuracy figures in the accuracy comparison. The framework also provides the basis for visual explanations of predictions made by the model by using visualizations provided by Grad-CAM technology due to the integration of information obtained from both models that complement each other. It has been demonstrated that the model may prove to be a powerful AI-assisted screening tool in DR diagnostics.

Keywords: Deep Learning, Diabetic Retinopathy, Grad-CAM, Hybrid Model, Medical Image Analysis