

ABSTRACT

Diabetes mellitus is a chronic metabolic disease that can lead to various complications, one of which is Diabetic Retinopathy (DR), the leading cause of blindness worldwide. Early detection of DR is crucial to prevent severe consequences. Deep learning methods have proven effective in the early detection of DR, reducing subjectivity in diagnosis and improving the accuracy of patient condition identification. One of the main challenges in classifying DR severity levels is class imbalance, where the number of samples in the minority class is significantly lower than in other classes. To address this issue, this study proposes a deep learning model based on EfficientNetB0, incorporating an upsampling technique and hyperparameter optimization. The upsampling technique is applied to balance the number of samples in minority classes, allowing the model to learn more effectively and improve classification performance across all severity levels. Additionally, data augmentation techniques, such as flipping, sharpening, Gaussian blur, and noise addition, are implemented to enhance the diversity of training data and further improve model robustness. This study utilizes the Asia Pacific Tele-Ophthalmology Society (APTOS) 2019 dataset, consisting of retinal fundus images with varying DR severity levels, to train and evaluate the deep learning model. The best-performing model achieved an accuracy of 80.44%, demonstrating its effectiveness in classifying all DR severity levels, including minority classes that were previously difficult to detect. To better understand the model's decision-making process, Grad-CAM analysis was used for interpretability. The results indicate that the model successfully identifies key DR features, such as microaneurysms and vitreous hemorrhage, which are crucial indicators for diagnosis. The findings of this study confirm that the combination of upsampling techniques, data augmentation, and the EfficientNetB0-based deep learning model effectively addresses the class imbalance problem in DR classification. The proposed model has great potential to enhance early detection and support healthcare professionals in making more accurate diagnoses.

Keywords : *Severity of Diabetic Retinopathy, Deep Learning, Data Augmentation, EfficientNetB0, Upsampling Technique*