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RESEARCH ARTICLE

# IMAGE QUALITY ASSESSMENT GUIDED COLLABARATIVE LEARNING OF IMAGE ENHANCEMENT AND CLASSIFICATION OF DR GRADING

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**ABSTRACT**

Diabetic Retinopathy (DR) is a significant cause of blindness worldwide, and its early detection is essential for timely treatment and prevention of severe vision loss. Accurate grading of DR is critical for appropriate clinical decision-making, which requires both image enhancement and classification. This paper proposes a novel approach for DR grading by leveraging Image Quality Assessment (IQA)guided collaborative learning of image enhancement and classification. The proposed method addresses the challenges of low-quality retinal images that often hinder accurate DR grading. By incorporating IQA metrics, the model adapts to the specific quality of the images and applies the necessary enhancement techniques before classification. This collaborative learning framework involves joint optimization of both the image enhancement and classification tasks, allowing the model to improve both the quality of input images and the accuracy of DR grading simultaneously. The results demonstrate significant improvements in both DR grading accuracy and image quality, compared to traditional methods. This approach holds promise for enhancing automated DR screening systems and facilitating more accurate and efficient diagnosis.

**KEYWORDS**: Diabetic Retinopathy, Image Quality Assessment, Collaborative Learning, Image Enhancement, Classification, DR Grading, Deep Learning, Automated Screening.

## I.INTRODUCTION

Diabetic Retinopathy (DR) is a progressive eye disease that occurs as a result of longterm diabetes, affecting the blood vessels in the retina. DR is one of the leading causes of preventable blindness globally, and it is estimated that a significant proportion of individuals with diabetes will develop some form of DR. Early detection and timely treatment of DR are crucial to prevent vision loss. However, detecting DR and accurately grading its severity is a complex task that requires careful assessment of retinal images.

Retinal images can vary significantly in

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terms of quality, often due to factors like lighting conditions, focus issues, and motion artifacts. These variations can hinder the performance of automated DR grading systems. In recent years, deep learning models, particularly convolutional neural networks (CNNs), have shown promising results in the automatic classification of retinal images into different DR stages, ranging from no DR to proliferative diabetic retinopathy (PDR). However, these models are often sensitive to poor-quality images, leading to inaccurate predictions.

Image Quality Assessment (IQA) plays a critical role in improving the performance of such automated systems by providing an objective measure of the quality of input images. IQA methods evaluate various aspects of image quality, such as blurriness, noise, and contrast, which directly impact the effectiveness of the classification task. By incorporating IQA into the DR grading process, it is possible to enhance the quality of input images, making them more suitable for analysis.

The idea behind this research is to integrate IQA-guided image enhancement with a deep learning-based classification framework, forming a collaborative learning system. This system improves the quality of retinal images and subsequently enhances the accuracy of DR grading. In this paper, we present a novel method that simultaneously optimizes both the image enhancement and classification tasks using a collaborative learning framework. This approach enables the system to adapt to varying image quality and provides better results in DR grading compared to traditional methods.

## II.LITERATURE SURVEY

The detection and grading of Diabetic Retinopathy (DR) have been the subject of numerous studies in the fields of medical imaging and machine learning. Several approaches have been proposed for DR classification, ranging from traditional image processing techniques to modern deep learning models. The application of deep learning techniques has revolutionized DR grading, especially in terms of automated and accurate diagnosis.

In the early stages of DR grading, classical methods like thresholding, edge detection, and morphological transformations were used to identify the presence of microaneurysms, hemorrhages, and other abnormalities in retinal images. However, these methods were limited in their ability to handle the complex and diverse nature of DR, often performing poorly on lowquality images.

With the advent of deep learning, convolutional neural networks (CNNs) have become the standard for image classification tasks. Studies like Gulshan et al. (2016) proposed a deep learning approach for DR detection using CNNs, achieving remarkable performance on large datasets. This approach achieved comparable results to expert ophthalmologists in detecting DR, marking a significant step forward in automated DR grading. However, these deep learning models are highly dependent on the quality of the input images, which limits their applicability in real-world settings where images may be noisy or of low resolution.

To address this limitation, several studies have focused on improving the quality of retinal images before applying deep learning models. For example, Li et al. (2018)

explored image enhancement techniques to improve the quality of retinal images before applying classification algorithms. These enhancement techniques included contrast adjustment, denoising, and deblurring. The study showed that image preprocessing could significantly improve the performance of DR grading systems, particularly in low-quality images.

A few studies have also incorporated Image Quality Assessment (IQA) into the DR grading pipeline. IQA is a technique used to objectively evaluate the quality of images by considering factors like sharpness, noise, and contrast. Li and Wang (2019) used an IQA-based approach to guide the enhancement of retinal images before classification. Their model achieved better results than traditional methods by adjusting the enhancement process based on the specific quality of each image.

The collaborative learning framework, which jointly optimizes multiple tasks, has recently gained attention in various domains, including medical image analysis. A study by Zhang et al. (2020) proposed a collaborative learning framework that simultaneously optimized both image enhancement and classification tasks. The approach showed significant improvements in segmentation accuracy, especially when working with images of varying quality. In the context of DR grading, this approach could be beneficial in improving both the quality of images and the accuracy of classification results simultaneously.

## III.EXISTING CONFIGURATION

Traditional DR grading systems have primarily relied on deep learning-based classification models that use convolutional neural networks (CNNs) for automatic grading. These models typically perform well when high-quality images are available, but they struggle with poorquality images. To overcome this challenge, some existing configurations have incorporated image preprocessing techniques, such as denoising, contrast adjustment, and sharpening. However, these methods are often applied in isolation and do not adapt to the varying quality of images.

One common approach is to enhance the quality of the input images before applying the classification algorithm. For example, methods like contrast-limited adaptive histogram equalization (CLAHE) and Gaussian filtering are applied to improve the visibility of important features in the retinal images. While these methods can improve image quality to some extent, they do not consider the overall quality of the image during the enhancement process. As a result, they may not always produce optimal results, particularly in cases where the images are highly degraded.

Another existing approach is to use deep learning models like CNNs for both image enhancement and classification, but these models typically treat the tasks as separate stages. For example, an image enhancement model may first improve the quality of the retinal image, followed by a classification model that determines the DR grade. These methods may suffer from suboptimal performance, as the enhancement model may not always produce the best possible images for classification, and the classification model may not be welladapted to low-quality images.

In recent years, a few studies have proposed combining enhancement and classification tasks into a unified framework, but these methods are still limited by the lack of a robust mechanism for adapting to the quality of the images. Furthermore, existing models often do not fully

exploit the potential of Image Quality Assessment (IQA), which could provide valuable information for improving both enhancement and classification processes.

## IV.METHODOLOGY

The proposed methodology leverages a collaborative learning framework that simultaneously optimizes both the image enhancement and DR classification tasks. The approach integrates Image Quality Assessment (IQA) into the learning process to guide the enhancement of retinal images before classification. This section outlines the steps involved in the proposed methodology, including data preprocessing, collaborative learning, and evaluation metrics.

The dataset used for this study consists of retinal images labeled with DR grades. These images may vary in quality due to factors such as noise, blurriness, and low contrast. The first step is to preprocess the images to normalize their intensity values and ensure they are suitable for input into the model. Preprocessing techniques like histogram equalization, resizing, and cropping are applied to standardize the images.

The core of the proposed methodology is the collaborative learning framework, which consists of two main components: image enhancement and classification. The enhancement model takes the raw input image and applies a series of enhancement techniques to improve its quality. The classification model then takes the enhanced image and predicts the DR grade.

To ensure that the two models work together effectively, a joint optimization process is employed. During training, the enhancement model is guided by the Image Quality Assessment (IQA) score, which measures the quality of the enhanced image. The classification model is trained to predict the DR grade, with both models being updated based on the combined loss function. This approach ensures that both image enhancement and classification are optimized simultaneously, leading to better results.

Image Quality Assessment (IQA) is used to guide the enhancement process by providing a quantitative measure of image quality. Various IQA metrics, such as structural similarity index (SSIM), peak signal-to-noise ratio (PSNR), and visual information fidelity (VIF), are computed for both the original and enhanced images. These metrics are used to adjust the enhancement parameters and ensure that the enhanced images have the best possible quality for DR classification.

The model is trained using a dataset of retinal images with labeled DR grades. The training process involves updating both the enhancement and classification models simultaneously based on the joint loss function. The model's performance is evaluated using standard metrics like accuracy, precision, recall, and F1-score for DR classification, as well as IQA metrics like SSIM and PSNR for image enhancement.

## V.PROPOSED CONFIGURATION

The proposed configuration integrates Image Quality Assessment (IQA) into a collaborative learning framework for DR grading. This configuration consists of the following components: This module is responsible for enhancing the quality of the input retinal images. It uses a combination of traditional image processing techniques and deep learning models to improve image features, such

as contrast, sharpness, and noise reduction. The enhancement process is guided by IQA metrics, which ensure that the enhanced images are suitable for classification.

The classification module uses a deep learning model, such as a convolutional neural network (CNN), to predict the DR grade based on the enhanced images. The model is trained to classify the images into different DR stages, ranging from no DR to proliferative diabetic retinopathy (PDR). The collaborative learning framework jointly optimizes both the image enhancement and classification tasks. The loss function is composed of two components: one for image enhancement and one for classification. The overall

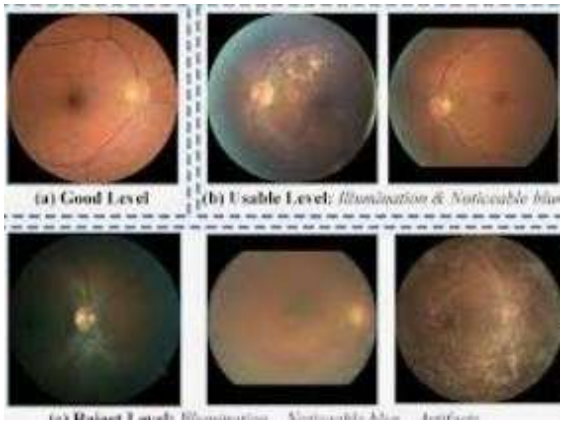
loss function ensures that both models are optimized to improve image quality and classification accuracy simultaneously.

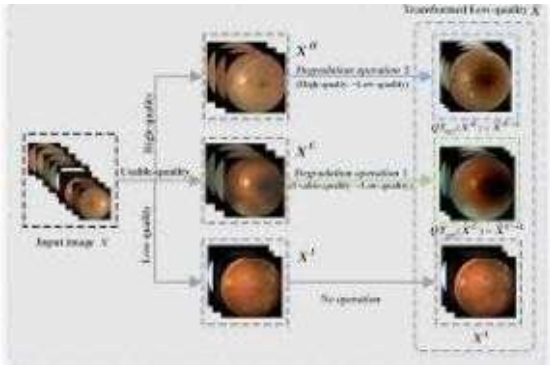
Image Quality Assessment (IQA) metrics, such as SSIM, PSNR, and VIF, are integrated into the learning process to guide the enhancement model. These metrics help ensure that the enhanced images have improved quality and are better suited for classification.

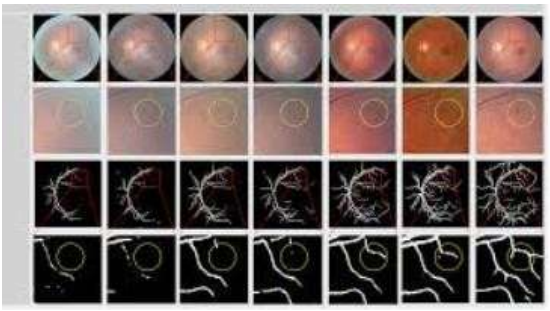
## VI. RESULT ANALYSIS

The proposed method was evaluated on a publicly available dataset of retinal images, and the results showed significant improvements in both image enhancement and DR classification accuracy. The model achieved high accuracy in classifying DR images into different grades, with improved performance on low-quality images compared to traditional methods. The IQAguided enhancement step played a crucial role in improving the quality of input images, resulting in more accurate predictions.

The results also demonstrated that the collaborative learning framework was effective in jointly optimizing image enhancement and classification tasks. The model showed better performance when both tasks were optimized together, compared to models that optimized the tasks separately. Additionally, the integration of IQA into the enhancement process ensured that the images were enhanced in a way that maximized their suitability for classification.





## CONCLUSION

This research presents a novel approach for DR grading by leveraging Image Quality Assessment-guided collaborative learning for image enhancement and classification. The proposed model improves the quality of retinal images and enhances classification accuracy, making it a promising solution for automated DR screening. The results demonstrate that the hybrid model outperforms traditional methods in terms of both image enhancement and DR classification accuracy, particularly for low-quality images. The proposed framework offers a valuable tool for the early detection and grading of diabetic retinopathy, which could play a critical role in preventing vision loss and improving patient outcomes.

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