ABSTRACT

Deep learning (DL) techniques provide optimized solutions in a wide range of applications, such as natural language processing, face recognition, speech recognition, image analysis, and much more. Deep learning progresses from machine learning models, where the learning data is associated with task-based methods. Deep learning is identified as an effective way to handle complex image representation. Recently, the insights gained from deep learning techniques have aided the healthcare industry, especially in the medical imaging sector. Medical imaging is one of the high-priority areas for potential research with computer-aided medical devices, especially for disease diagnosis, disease monitoring and treatment. Internal organs such as the brain, retina, lungs, abdomen, kidneys, and much more can be captured in detail using medical imaging technology.

This study focuses on exploring retinal disorders, which aids ophthalmologists in identifying the stages of diabetic retinopathy disease. Diabetic Retinopathy (DR) is an eye disease that affects the vision of a diabetic patient and can lead to blindness in its advanced stages. The rising number of diabetic patients worldwide is a necessity for emerging techniques in the present era. Scanning the retinal image to analyze the blood vessel layers at the rear of the eye is performed in retinal biometrics. The seepage on blood vessels in the retina in diabetic patients is the cause of permanent blindness. A digital photograph of a retina is used for screening patients with DR and Glaucoma diseases. Deep learning models aid in the classification of retinal images, providing optimized solutions.

The objective of this study is to improve the classification performance of diabetic retinopathy stages using an optimized convolutional neural network-based ensemble classification and regression framework. A deep learning technique, Convolutional Neural Networks (CNNs), is employed in the form of pre-trained resnet-34 for DR stage classification. The contributions of this research work primarily focus on the preprocessing and augmentation phase, where a two-stage image preprocessing framework is proposed that involves a wavelet-based hybrid denoising method to eliminate Gaussian and Salt-and-pepper noises present in retinal fundus images followed by contrast enhancement, and augmentation to balance the dataset classes.

As a part of feature extraction and classification, three different CNN-based deep learning models have been developed. These models aim to improve the performance of DR multi-class classification. The contributions in this section include, 1. Application of the Multi-Scale Attention (MSA) mechanism to a pre-trained CNN model, ResNet-34 (Residual Neural Network), in combination with a gradient-boosting classifier for DR classification tasks. 2. The utilization of Special Generative Adversarial Networks (SGAN) to generate realistic retinal images is followed by ensemble classification and regression blocks, as well as a Multilayer Perceptron (MLP) classifier for DR stage classification tasks. 3. Mine Blast Algorithm (MBA) enhancement to select the optimal set of hyper-parameters for tuning the deep learning model, thereby improving the classification performance of DR stages.