National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: On the Development of Hybrid Deep Learning Techniques for Diabetic Retinopathy Grading Analysis
Speaker	: K Ashwini (Rollno : 519cs1002)
Supervisor	: Ratnakar Dash
Venue	: Convention Hall, CS Department
Date and Time	: 13 Aug 2025 (16:00 Hrs)
Abstract	: The thesis presents Hybrid deep learning models for Diabetic Retinopathy Grading. The study leverages various deep learning techniques along with multiresolution analysis for grading of Diabetic Retinopathy. Attempt has been made to solve various issues in DR grading. In this regard, four contributions are made using Fundus images. The first three contributions address the DR grading issues while the fourth contribution focuses on how Generative AI such as GAN can be used for generating samples for DR grading. 1. The first contribution proposes a weighted ensemble model of pre-trained models (Inceptionv3, ResNet50V2 and InceptionResnetV2) combined with soft attention for DR grading. The suggested approach applies transfer learning to extract features from retinal images from three best-performing models, such as Inceptionv3, ResNet50V2, and InceptionResNetV2. Hence, an ensemble of best-performing pre-trained models is introduced to combine the strengths of these models to capture diverse feature representations. Additionally, a soft attention mechanism is incorporated to guide the model&rsquos focus toward the most informative retinal regions, improving sensitivity to subtle lesions. 2. The second contribution proposes a hybrid system integrating the Discrete wavelet transform with Convolutional neural networks for multi-resolution feature extraction. The multi-resolution decomposition capability of DWT enables detailed feature extraction by breaking down fundus images into low-frequency and high-frequency components, which are then analyzed through a CNN. The extracted features are subsequently fed into fully connected layers for classification. This approach captures both fine and coarse details in fundus images, allowing CNNS to extract meaningful features at different resolutions. 3. The third contribution focuses on improving the detection of mild-stage DR, which is particularly challenging due to the size of the microaneurysms. A hybrid feature extraction strategy has been proposed where Local Binary Pattern is applied to enhance texture features, and CLAHE has been applied to enhance vessel features. Further, CNNs are employed to process these refined features, which are later combined for final classification. This two-block CNN approach aims to increase the sensitivity of DR detection, particularly in the early stages. 4. The fourth contribution investigates the impact of GAN-generated images on DR grading and introduces a custom loss function to handle dataset imbalance. In this regard, an Attention-based Balanced GAN has been proposed to generate synthetic high-quality fundus images. However, the experiments performed show that the traditional geometric transformations outperform GAN-based augmentation due to the limited realism of synthetic images. Additionally, a Performance Aware Weighted Loss (PAWL) function is introduced to mitigate class imbalance, ensuring equitable learning across all DR severity levels. The above mentioned contributions are validated on standard publicly available datasets namely, IDRiD, APTOS, DDR, and EyePACS. Various performance measures including sensitivity, specificity, accuracy etc. are tested and comparative performance analysis is done with respect to the recently reported competent schemes.