MODULE 1: To develop an improved CNN architecture and algorithm for automatic detection and classification of DR.

Project Overview

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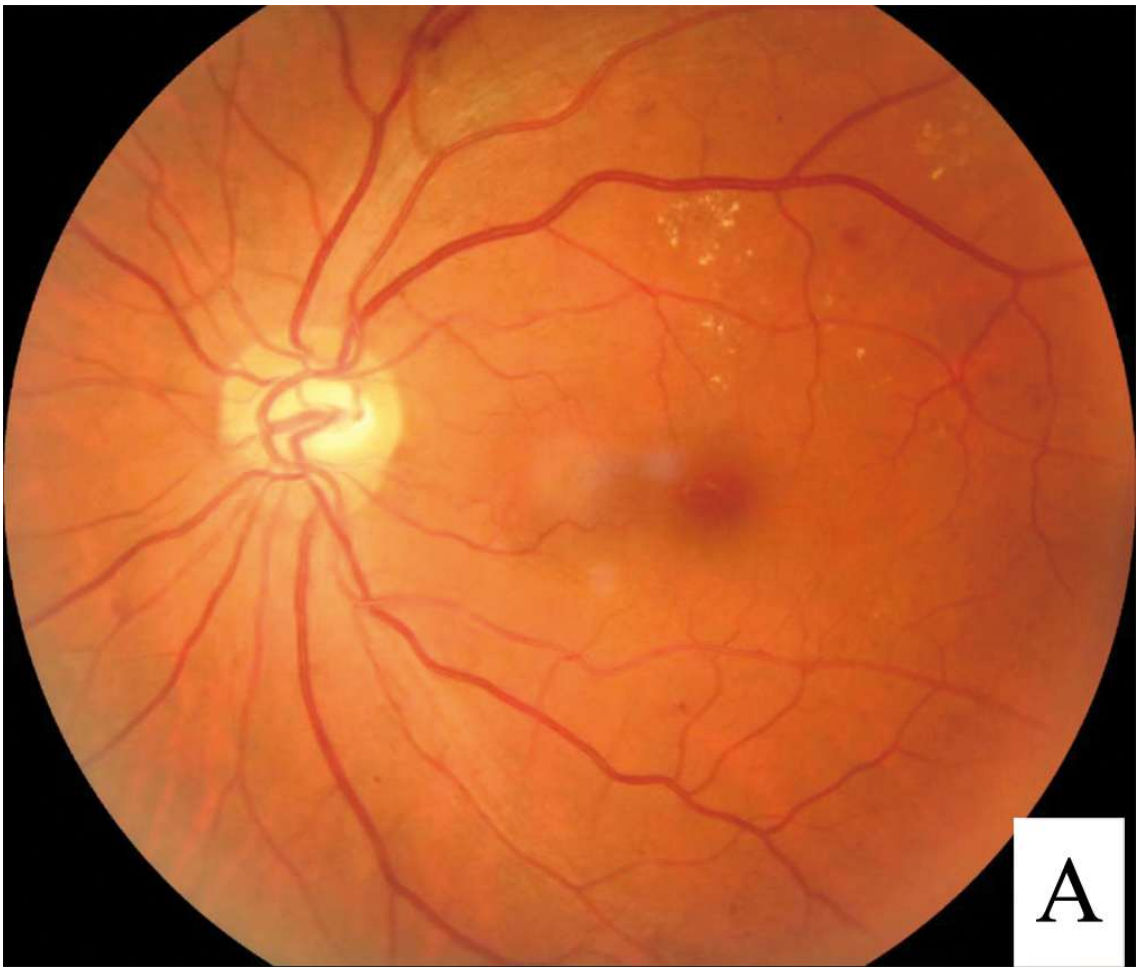

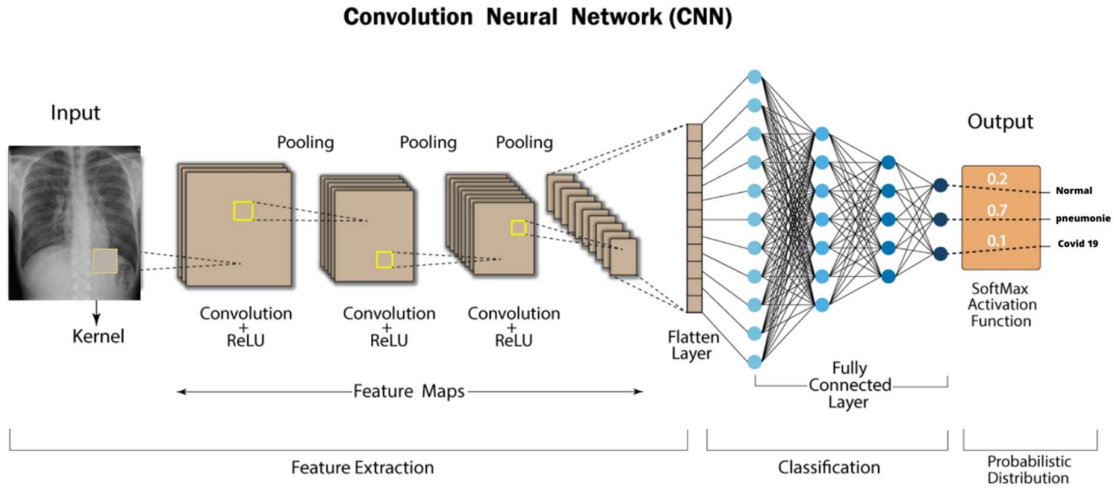

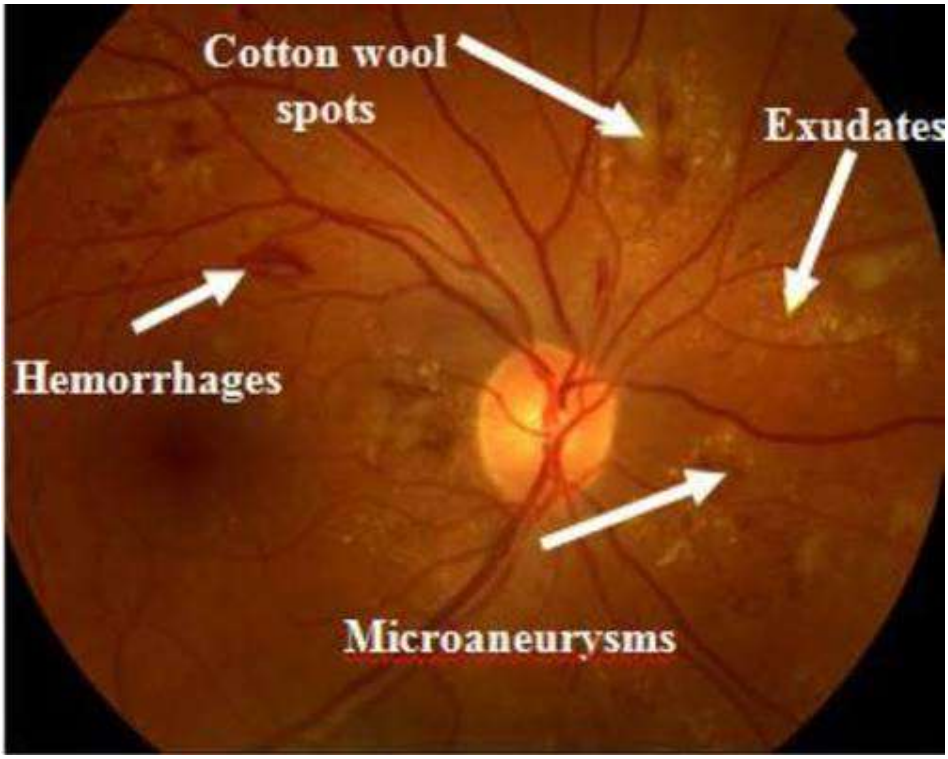

Problem Statement

Diabetic Retinopathy (DR) is a diabetes-related eye disease that can lead to irreversible vision loss if not detected at an early stage. Manual screening of retinal fundus images by ophthalmologists is time-consuming, costly, and prone to inter-observer variability. Hence, there is a strong need for an automated, accurate, and scalable diagnostic system.

Objective

To develop an improved Convolutional Neural Network (CNN) architecture and classification algorithm capable of automatically detecting and classifying Diabetic Retinopathy from retinal fundus images with higher accuracy, robustness, and reduced false positives.

Proposed Methodology

1. Data Acquisition

- Retinal fundus images collected from publicly available DR datasets
- Images categorized into multiple classes such as:
    - No DR
    - Mild
    - Moderate
    - Severe
    - Proliferative DR

2. Image Preprocessing

- Image resizing and normalization
- Contrast enhancement using histogram equalization
- Noise reduction and background removal
- Data augmentation (rotation, flipping, zooming) to reduce overfitting

3. Improved CNN Architecture

The proposed CNN model is designed with:

- Multiple convolutional layers for hierarchical feature extraction
- Batch normalization to stabilize training
- Dropout layers to reduce overfitting
- ReLU activation for non-linearity

- Softmax output layer for multi-class classification

Key improvements include:

- Deeper feature extraction for lesion detection (microaneurysms, hemorrhages)
- Optimized kernel sizes for retinal pattern recognition
- Reduced model complexity while maintaining performance

4. Training and Optimization

- Loss function: Categorical Cross-Entropy
- Optimizer: Adam
- Learning rate tuning for faster convergence
- Model trained and validated using train-test split

5. Classification and Prediction

- Model predicts DR stage from unseen retinal images
- Output probability scores indicate confidence level
- Performance evaluated using accuracy, precision, recall, F1-score, and confusion matrix

Results and Performance

- Improved classification accuracy compared to traditional CNN models
- Enhanced sensitivity for early-stage DR detection
- Reduced misclassification between adjacent DR severity levels

Applications

- Automated screening systems in hospitals and clinics
- Tele-ophthalmology platforms for rural healthcare
- Decision support tools for ophthalmologists

- Early diagnosis and preventive eye care

Conclusion

The developed improved CNN-based system provides an effective and reliable solution for the automatic detection and classification of Diabetic Retinopathy. By leveraging advanced deep learning techniques, the model enhances diagnostic accuracy, reduces human dependency, and supports early intervention, ultimately helping to prevent vision loss.