Explainable AI for Early Detection and Characterization of Retinal Pathologies in OCT

Team Number:14

Jeyasakthi R(21H019),Kavyaa S M(21H021),

Mivetha K(21H030)

Guide: Mrs.Priya Thiagarajan

Research Area Identified

- **Type the Research area identified:** Artificial Intelligence in Medical Imaging

- **Specific Research area:** Retinal Disease Classification Using OCT Images

Problem Statement

- Early detection of retinal diseases is crucial to prevent vision loss, but traditional diagnosis is time-consuming and expertise-dependent.
- Diseases considered :**Choroidal neovascularization(CNV),Diabetic Macular Edema(DME),Drusen**
- **Explainable AI-powered OCT analysis** ensures faster, more accurate, and transparent detection, providing insights into the decision-making process for better clinical trust and reliability.
- **Target Users:** Ophthalmologists, healthcare institutions, and AI-based diagnostic systems.

Objectives

- To create an explainable AI-based model for retinal illness classification that offers precise diagnoses together with open information on the decision-making process
- To improve the efficiency and accuracy of diagnosis
- To assist medical systems and ophthalmologists

Tools and Technologies proposed to be used

- Jupyter notebook
- Packages:numpy,matplotlib,keras,tensorflow, Torch,torchvision,shutil,opencv
- Dataset: Mendeley Data(Labeled Retinal Optical Coherence Tomography Dataset for Classification of Normal, Drusen, and CNV Cases - Mendeley Data)

Literature survey (5 Recent Papers) For R&D projects

Title of the paper	Journal name and year of publication	Q1/Q2/Q3/Q4	Inference of the paper (bulleted points)
Multi-Label Retinal Disease Classification Using Transformers	IEEE Journal of Biomedical and Health Informatics, June 2023	Q1	• Introduction of the MuReD dataset, which combines various publicly available datasets, specifically for multi-label retinal disease classification. • Achieved better performance than state-of-the-art techniques by 7.9% in disease detection and 8.1% in disease classification

Literature survey (5 Recent Papers) For R&D projects

Title of the paper	Journal name and year of publication	Q1/Q2/Q3/Q4	Inference of the paper (bulleted points)
A two-stage CNN model for the classification and severity analysis of retinal and choroidal diseases in OCT images	International Journal of Intelligent Networks,2024	Q1	• The proposed system is a novel pipeline designed for the classification and grading of retinal diseases using Optical Coherence Tomography (OCT) images. • It leverages machine learning and image processing techniques to streamline and enhance the diagnostic process.

Literature survey (5 Recent Papers) For R&D projects

Title of the paper	Journal name and year of publication	Q1/Q2/Q3/Q4	Inference of the paper (bulleted points)
Feasibility study to improve deep learning in OCT diagnosis of rare retinal diseases with few-shot classification	Medical & Biological Engineering & Computing,2021	Q2	• AI Can Perform at Par with or Better Than Human Experts • GAN-Based Augmentation Helps Overcome Data Shortage

Literature survey (5 Recent Papers) For R&D projects

Title of the paper	Journal name and year of publication	Q1/Q2/Q3/Q4	Inference of the paper (bulleted points)
Quantitative assessment of choroidal parameters in type 1 macular neovascularization linked to central serous chorioretinopathy and neovascular age-related macular degeneration	Photodiagnosis and Photodynamic Therapy,2024	Q2	• This imaging technique provides a wide and detailed view of the choroid, making it a powerful tool for diagnosing choroidal disorders.

Literature survey (5 Recent Papers) For R&D projects

Title of the paper	Journal name and year of publication	Q1/Q2/Q3/Q4	Inference of the paper (bulleted points)
Artificial Intelligence in Retinal Screening Using OCT Images: A Review of the Last Decade (2013–2023)	*Computer Methods and Programs in Biomedicine,2024*	Q1	• Machine learning models struggle with feature selection, whereas deep learning models work better in an end-to-end manner. • Effectiveness of AI in Retinal Disease Detection

Module description for both R&D and industry

Module 1: Gathering and Preparing Data

1. : Data collection
2. : Data Splitting(Training 80, Testing 10, validating 10)
3 : Image Pre-Processing(Data -Augumentation, Segmentation)

Module 2: Model Development and Training

1. :Model Training(InceptionV3, MobileNetV2, EfficientNetB4)
2. : Model Selection(InceptionV3)

Module description for both R&D and industry

Module 3: Optimizing Models

1. : Adam Optimizer

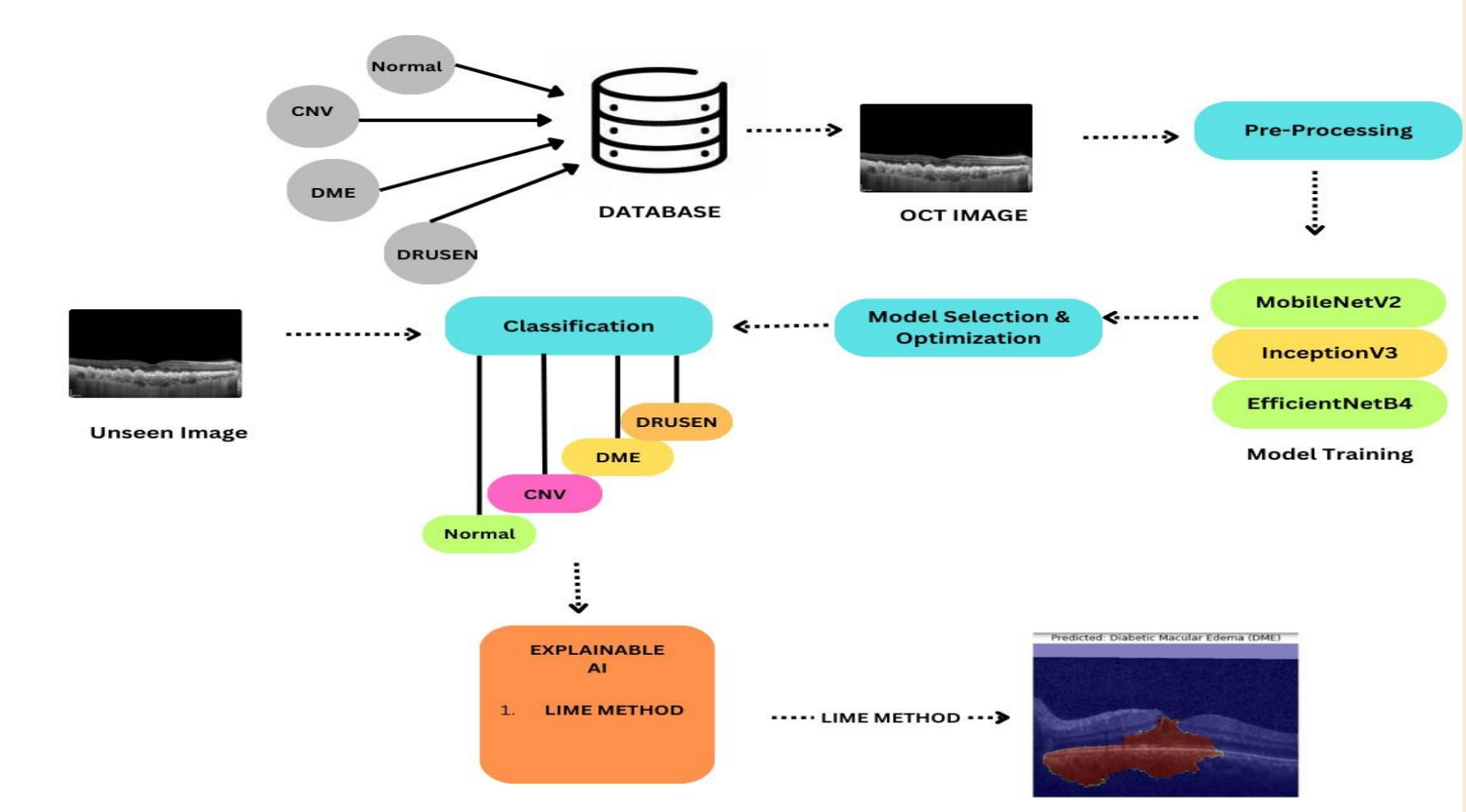
Module 4: Disease Classification and Prediction with Explainable AI Prediction Generation

1. : Explainability Analysis(Lime, Grad-CAM, Grad-CAM++)
2. : LIME Prediction

Module 5: Performance Analysis and Evaluation

1. : Accuracy and Loss Metrics.
2. : Confusion Matrix
3. : Comparison with Other Models

Work flow diagram



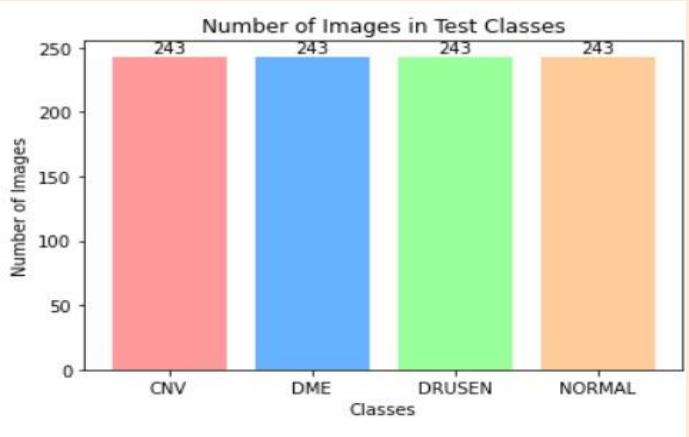
Result and Inference

Model	Accuracy(%)
InceptionV3	98.76
MobileNetV2	92.56
EfficientNet-B4	90.62

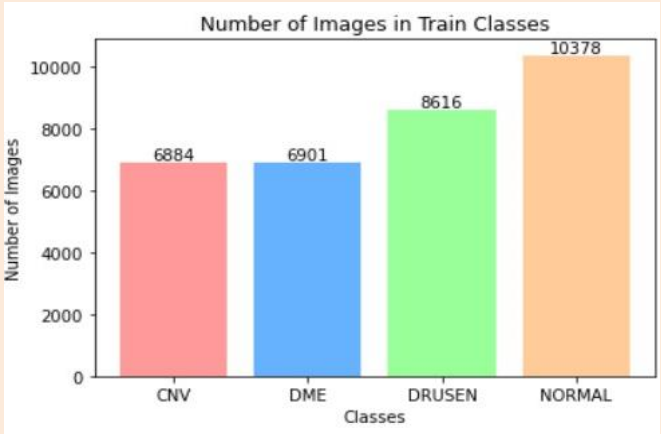
With an accuracy of **98.76%**, InceptionV3 outperformed MobileNetV2 (92.56%) and EfficientNet-B4 (90.62%) among the models we evaluated. **InceptionV3 is the greatest option** for our forecasts because it produces the most accurate results, which increases its dependability for our requirements.

Result and Inference -Inception V3

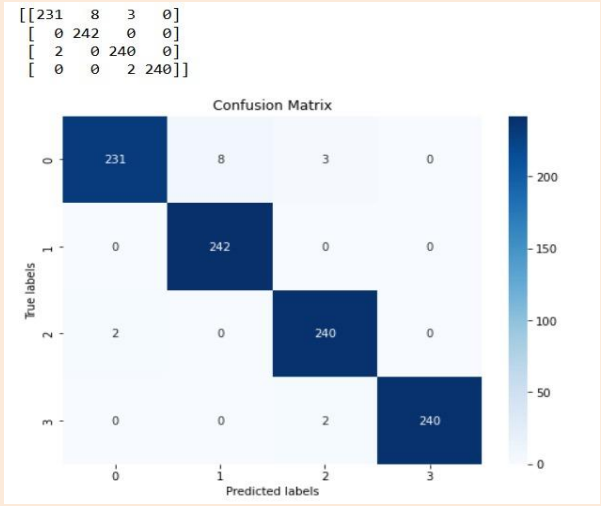
Bar Chart-Test Classes



Bar Chart-Train Classes



Confusion Matrix



Result and Inference
Classification Report

MobileNetV2

	precision	recall	f1-score	support
CNV	0.89	0.96	0.92	242
DME	0.94	0.94	0.94	242
DRUSEN	0.98	0.80	0.88	242
NORMAL	0.91	1.00	0.95	242
accuracy			0.93	968
macro avg	0.93	0.93	0.92	968
weighted avg	0.93	0.93	0.92	968

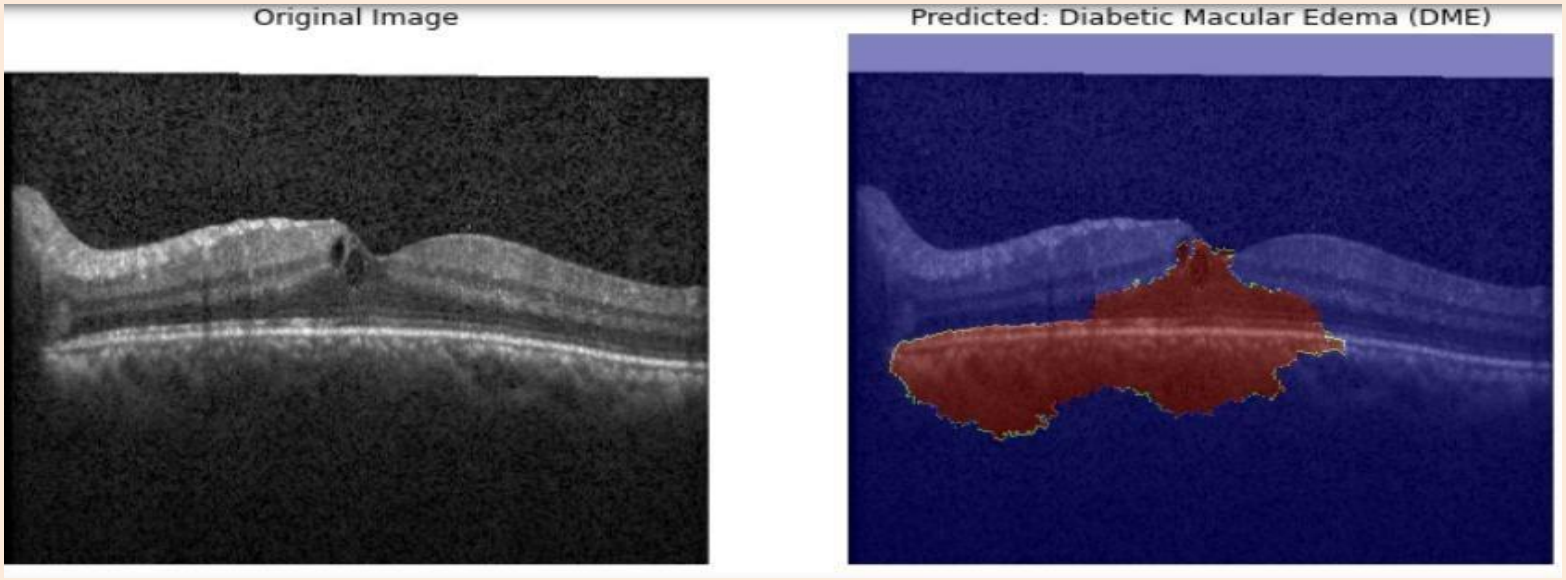
EfficientNet-B4

	precision	recall	f1-score	support
0	0.88	0.87	0.87	242
1	0.79	0.75	0.77	242
2	0.79	0.71	0.75	242
3	0.81	0.95	0.88	242
accuracy			0.82	968
macro avg	0.82	0.82	0.82	968
weighted avg	0.82	0.82	0.82	968

InceptionV3

	precision	recall	f1-score	support
0	0.99	0.95	0.97	242
1	0.97	1.00	0.98	242
2	0.98	0.99	0.99	242
3	1.00	0.99	1.00	242
accuracy			0.98	968
macro avg	0.98	0.98	0.98	968
weighted avg	0.98	0.98	0.98	968

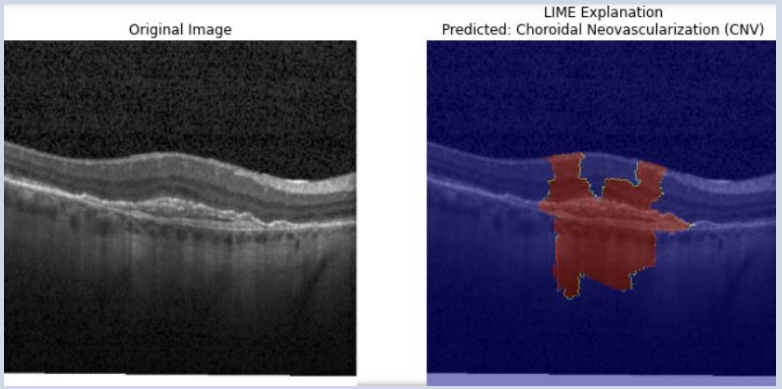
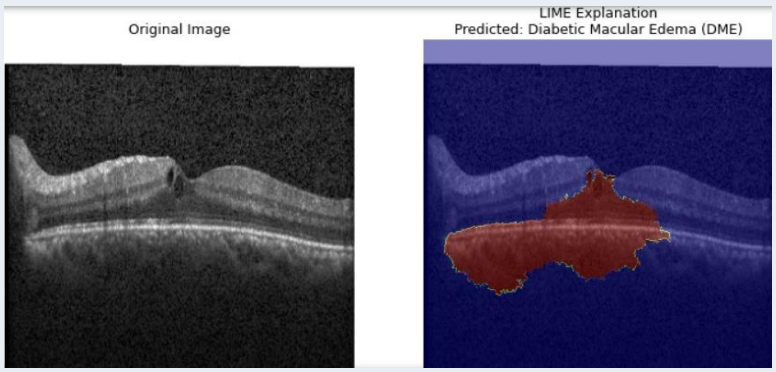
Result and Inference



Diabetic macular edema (DME) was correctly identified by the **InceptionV3** model, and the afflicted region was highlighted by **LIME**.

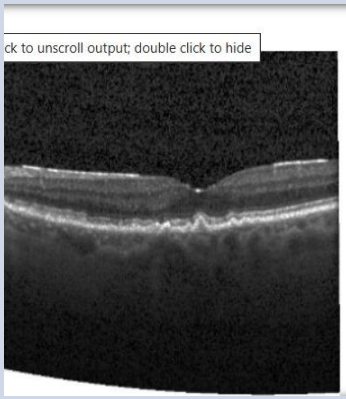
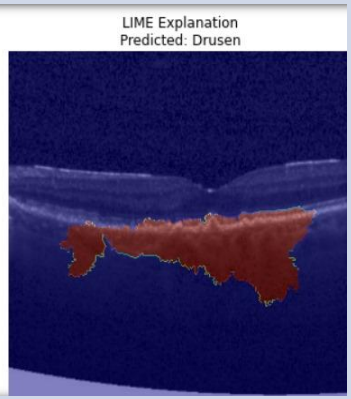
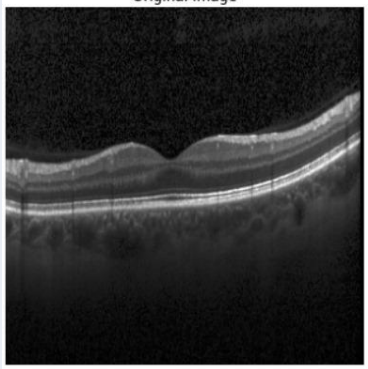
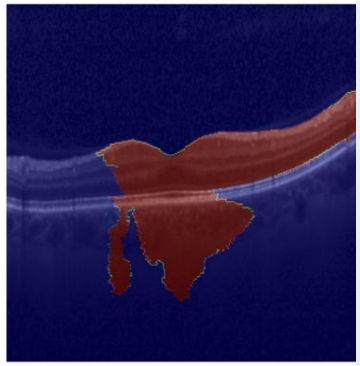
Result and Inference

Lime Method

Disease Name	Result Original Image	Predicted Image
Choroidal neovascularization (CNV)		
Diabetic macular edema (DME)		

Result and Inference

Lime Method

Disease Name	Results Original Image	Predicted Image
Drusen		
Normal Condition		

References

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