AN APPROACH FOR THE AUTOMATED IDENTIFICATION OF PTERYGIUM AND PINGUECULA IN OCULAR IMAGES

★★★ This research is accepted to be published and will also be indexed in IEEE and Scopus by ★★★
The 23rd International Joint Conference on Computer Science and Software Engineering (JCSSE 2026)
https://jcsse2026.org

Natthaphon Phimkhao | Panutad Sirikul | Natanun Janhom | Nutnicha Suphasueb | Apinya Tippin
Associate Professor Dr. Varin Chouvatut | Assistant Professor Benjamas Panyangam | Assistant Professor Dr. Matinee Kiewkanya

ABSTRACT

Conjunctival abnormalities, particularly pinguecula and pterygium, are serious public health concerns that have a negative impact on the quality of life and occupational productivity of working-aged and older people. Early and effective screening is thus essential for preventing the disease progression and minimizing the risk of long-term ocular problems. This study aims to develop and compare the performance of deep learning models in classifying digital eye images into normal and abnormal categories, where the abnormalities include pinguecula and pterygium. The study evaluated three pretrained convolutional neural network architectures: DenseNet121, EfficientNet-B4, and ResNet50. To improve diagnostic interpretability, the Gradient-weighted Class Activation Mapping (Grad-CAM) technique was adapted to generate heatmaps highlighting the clinically significant regions. Model performance was systematically measured using standard classification metrics, including accuracy, precision, and recall. The experimental results showed that DenseNet121 and ResNet50 consistently outperformed EfficientNet-B4 across all evaluation criteria. ResNet50 integrated with the heatmap analysis outperformed the other tested architectures in delivering the highest accuracy of 99.85%, while the incorporation of Grad-CAM further reduced false-negative cases. These findings suggest that combining deep learning architectures with explainable AI techniques can provide a reliable and interpretable framework for preliminary ophthalmic screening.

INTRODUCTION

Pinguecula and pterygium are common conjunctival conditions associated with chronic ultraviolet exposure and environmental stressors. If undetected, advanced pterygium can cause astigmatism and visual impairment. Current screening relies heavily on specialist examination, limiting accessibility in underserved communities and delaying early intervention. This study presents an automated classification system utilizing a Convolutional Neural Network (CNN) with Region of Interest (ROI) Emphasis and Data Augmentation to distinguish normal eyes from pinguecula and pterygium in external ocular images. Model performance is evaluated through Accuracy, Precision, Recall, and F1-score, with the aim of providing a scalable, AI-driven tool for community-level ocular health screening.

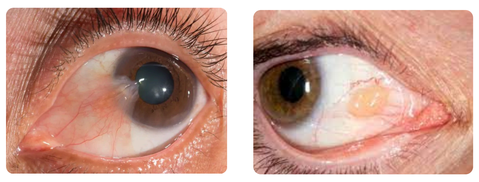
OBJECTIVES

1. Develop a deep learning model to classify Pterygium and Pinguecula from external eye images
2. Establish a lesion classification framework as a prototype for preliminary screening tools
3. Evaluate the model's reliability for primary screening using relevant statistical metrics.

DATASET



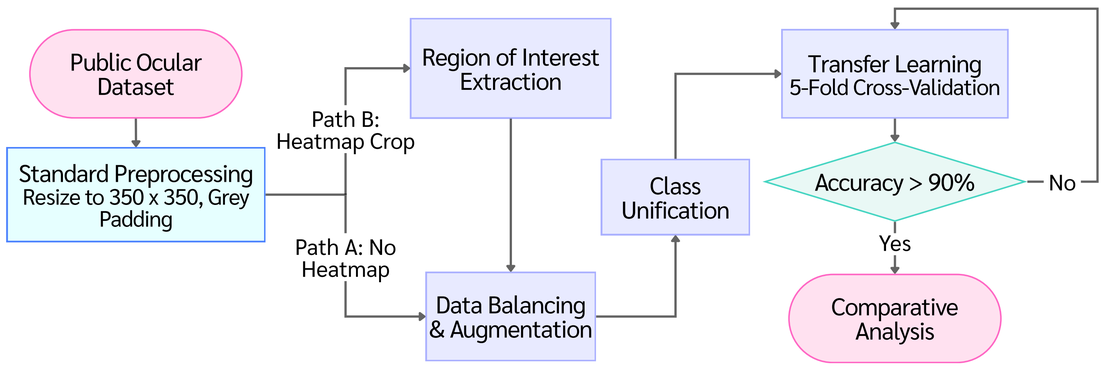
Normal
726 images



Abnormal
2,646 images

METHODOLOGY

Phase I: Data Preparation	Phase II: Preprocessing Strategies	Phase III: Model Training & Evaluation



MODELS

1 DenseNet-121
A CNN architecture featuring dense connectivity for optimized feature propagation in image classification and segmentation.

2 ResNet-50
A CNN architecture featuring residual learning and shortcut connections to optimize deep network training.

3 EfficientNet-B4
A CNN architecture featuring compound scaling of depth, width, and resolution for high accuracy and efficiency.

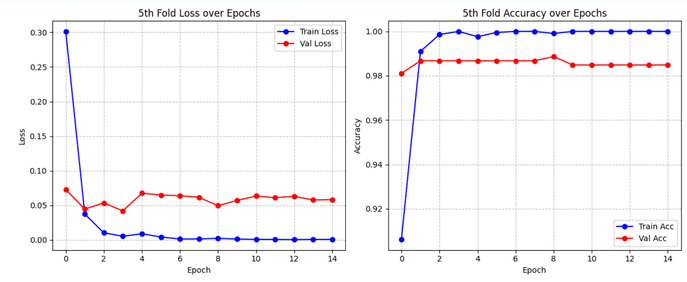
REFERENCES

[1] Tang, H., Ortis, A., & Battiato, S. (2019). The impact of padding on image classification by using pre-trained convolutional neural networks. International Conference on Image Analysis and Processing (ICIAP).
[2] Morbidelli, P., Carrera, D., Rossi, B., Fragneto, P., & Boracchi, G. (2020). Augmented Grad-CAM: Heat-maps super resolution through augmentation. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).
[3] Tan, M., & Le, Q. V. (2019). EfficientNet: Rethinking model scaling for convolutional neural networks. International Conference on Machine Learning (ICML).
[4] Eyezsmartdet. (2024). Pterygium computer vision dataset. Roboflow Universe. Eyezsmartdet. (2024). Pterygium computer vision dataset. Roboflow Universe. https://universe.roboflow.com/eyezsmartdet/pterygium
[5] Jittarawadee. (2024). Pinguecula-copy-s16sv computer vision dataset. Roboflow Universe. https://universe.roboflow.com/jittarawadee-6hlko/pinguecula-copy-s16sv

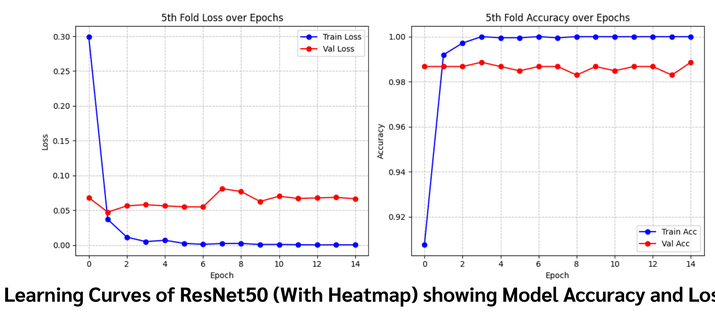
RESULT

Model Architecture	Heatmap	Acc (CV) (%)	Acc (Test) (%)	Precission (%)	Recall (%)	F1-Score (%)
DenseNet-121	Yes	99.62	99.70	99.40	100.00	99.70
	No	99.58	99.55	99.39	99.70	99.54
Resnet-50	Yes	99.55	99.85	100.00	99.70	99.85
	No	99.43	99.70	99.70	99.70	99.70
EfficientNet-B4	Yes	99.44	92.27	93.73	90.61	92.14
	No	93.25	93.48	93.62	93.33	93.48

LEARNING CURVE OF RESNET50

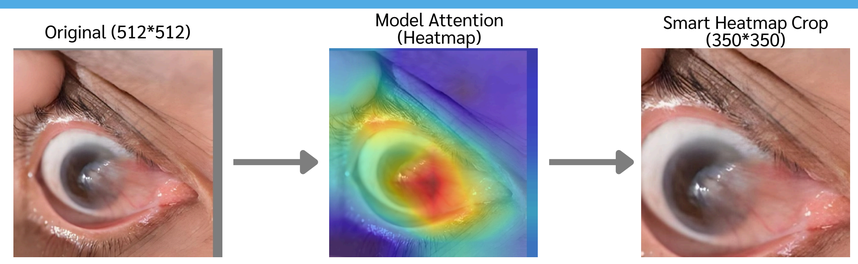


Training and Validation Learning Curves of ResNet50 (No Heatmap) showing Model Accuracy and Loss across 15 Epochs



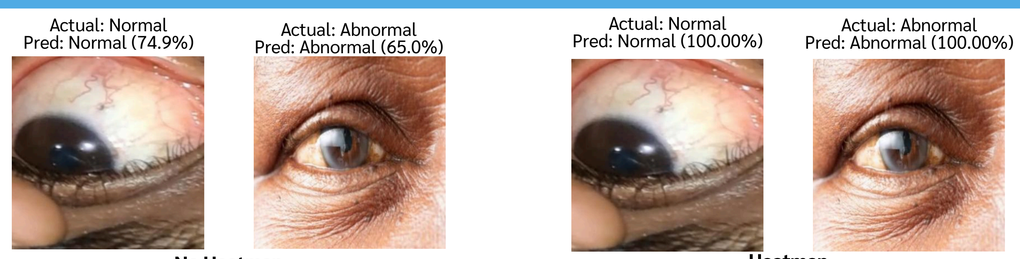
Training and Validation Learning Curves of ResNet50 (With Heatmap) showing Model Accuracy and Loss across 15 Epochs

GRAD-CAM VISUALIZATION



Grad-CAM (Gradient-weighted Class Activation Mapping) was utilized to localize lesions, automatically extracting the Region of Interest

PERFORMANCE COMPARISON



No Heatmap **Heatmap**

CONCLUSION & DISCUSSION

A comparative analysis identifies ResNet50 as the best model for ocular image classification, achieving an accuracy of 99.70%. When combined with Grad-CAM (Heatmaps), its accuracy improved to 99.85% with 100% Precision (eliminating false positives). DenseNet121 also performed strongly, reaching 100% Recall with Heatmaps to ensure no abnormal cases are missed. Conversely, EfficientNet-B4 performed the worst and responded negatively to Heatmaps, likely due to noise susceptibility. In conclusion, Heatmaps enhance both clinical explainability by visualizing lesions and the feature-focusing capabilities of ResNet50 and DenseNet121.