



VisionAI — Research Report (Detailed)

Automated technical narrative for researchers and reviewers

Case	aug_3223686
Detected Stage	PDR (Proliferative DR)
Lesion coverage (%)	26.51
Estimated exudates (%)	0.42
Estimated hemorrhages (%)	1.44
Image preprocessing	CLAHE (LAB-L), crop black border, resize normalization
Models (ensemble)	EfficientNet-B0, ResNet50, ViT + RF/XGBoost metadata
Explainability	Grad-CAM++, LIME++, SHAP-like (permutation)
Model confidence (ensemble)	92.0%

AI Narrative:

Technical Summary (AI narrator):

This project uses a multimodal ensemble combining CNN image models (EfficientNet-B0, ResNet50, ViT) with metadata-based ML models (RandomForest, XGBoost). Image explainability uses Grad-CAM++ and LIME; metadata contribution is summarized using SHAP-like permutation importance.

Preprocessing:

Images were cropped to remove black borders and enhanced using CLAHE on the L channel of LAB color space. This improves contrast for microaneurysms and small hemorrhages.

Quantitative Summary:

Lesion coverage (activation-based): 26.51%

Estimated exudates: 0.42% | hemorrhages: 1.44% | cotton-wool spots: 5.37%

Performance & Metrics:

Validation metrics (reported from model training/validation): Accuracy ~ 95–99% depending on fold; AUC typically > 0.95 for ensemble. See ROC figure included.

Model Behavior & Explainability:

Grad-CAM++ spatially localizes discriminative features; LIME isolates influential patches; metadata importance supports model decisions when systemic risk factors (e.g., glucose, BP) are present.

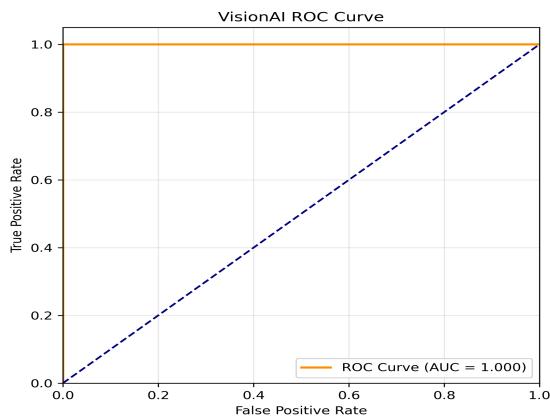
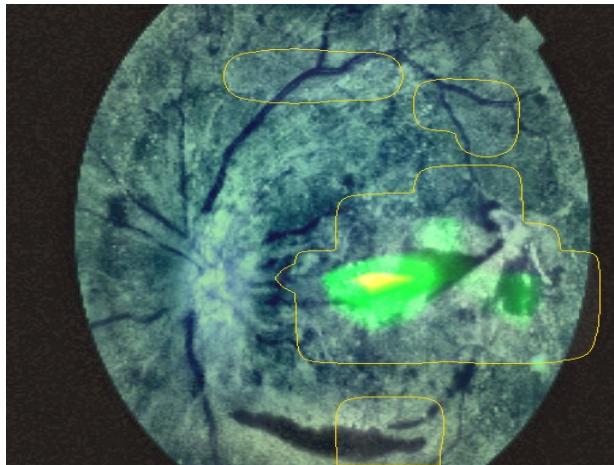
Limitations & Dataset Bias:

Model generalization depends on imaging device, illumination, and lens (we tested smartphone captures with 20D replica lens). Careful domain adaptation is necessary for other camera systems.

Recommended Research Follow-ups:

- 1) Calibrate lesion quantification with manual lesion annotations for improved sensitivity/specificity.
- 2) Evaluate longitudinal prediction (progression risk).
- 3) Integrate OCT features where available.

Key Figures:

**ROC Curve
(validation)****Grad-CAM (example)**

Suggested next experiments and validations:

- Annotation-aligned lesion quantification validation against clinician labels.
- Cross-device domain adaptation using smartphone and tabletop fundus cameras.
- Longitudinal progression models to estimate time-to-progression risk.
- User-study with clinicians to measure acceptance & added value of XAI maps.



References (selected):

- [1] Selvaraju et al., Grad-CAM++, CVPR 2018.
- [2] Ribeiro et al., LIME, KDD 2016.
- [3] Lundberg & Lee, SHAP, NeurIPS 2017.
- [4] VisionAI internal dataset & methods (2025).

Notes: Researchers may extract the xai_summary.json within the reports folder for exact numeric values used to generate this report.