

Artifact-Free AI Pipeline for Reliable Diabetic Retinopathy (DR) Diagnosis

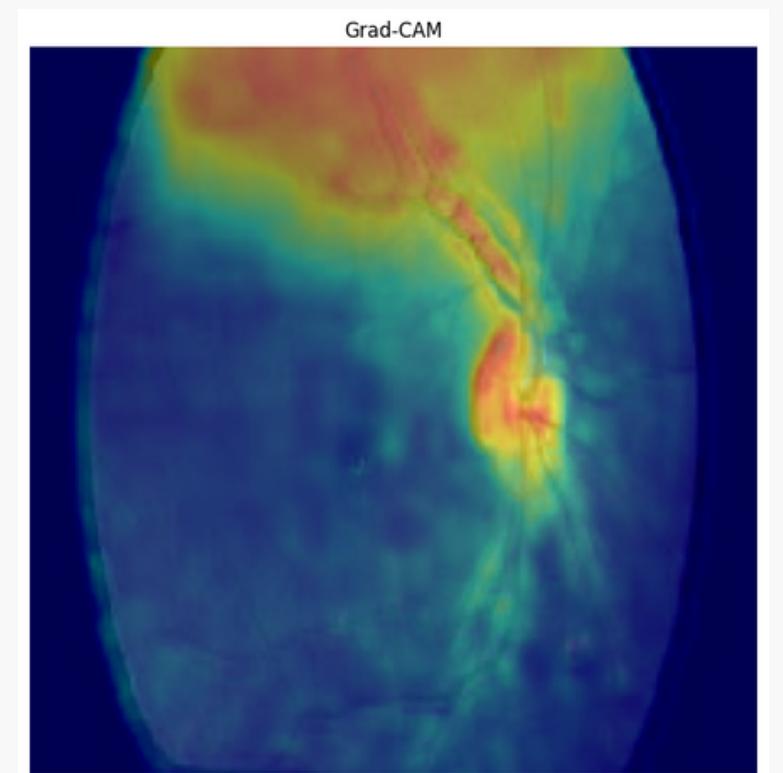
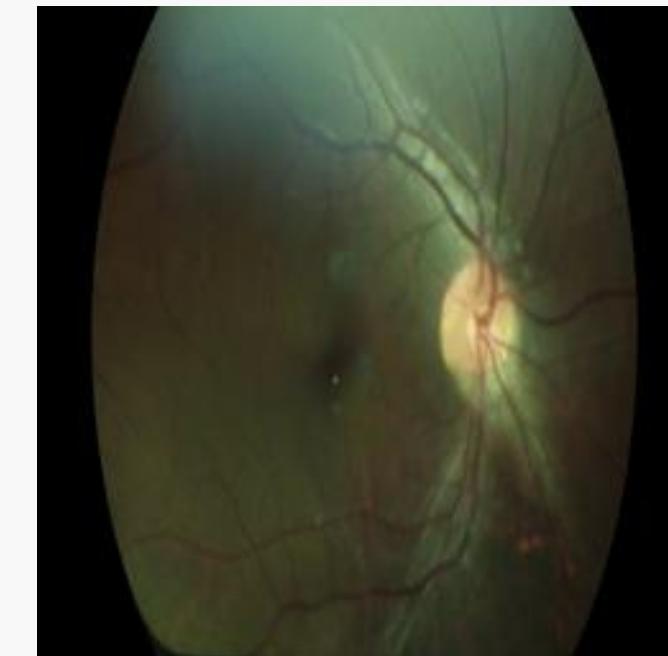
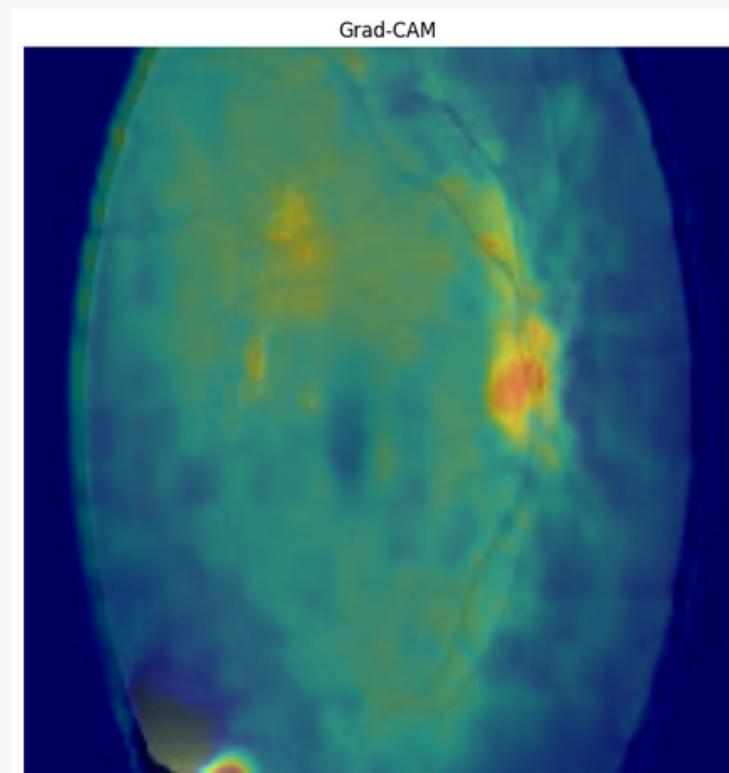
AI in Healthcare & Diagnostics

Problem Statement

Diabetic Retinopathy (DR) detection suffers from low model accuracy due to image artifacts like glare and camera flash, misleading AI models and reducing trust in diagnosis.

Observed Issue:

- Grad-CAM analysis shows models focus on artifacts.
- Artifacts degrade performance and explainability.

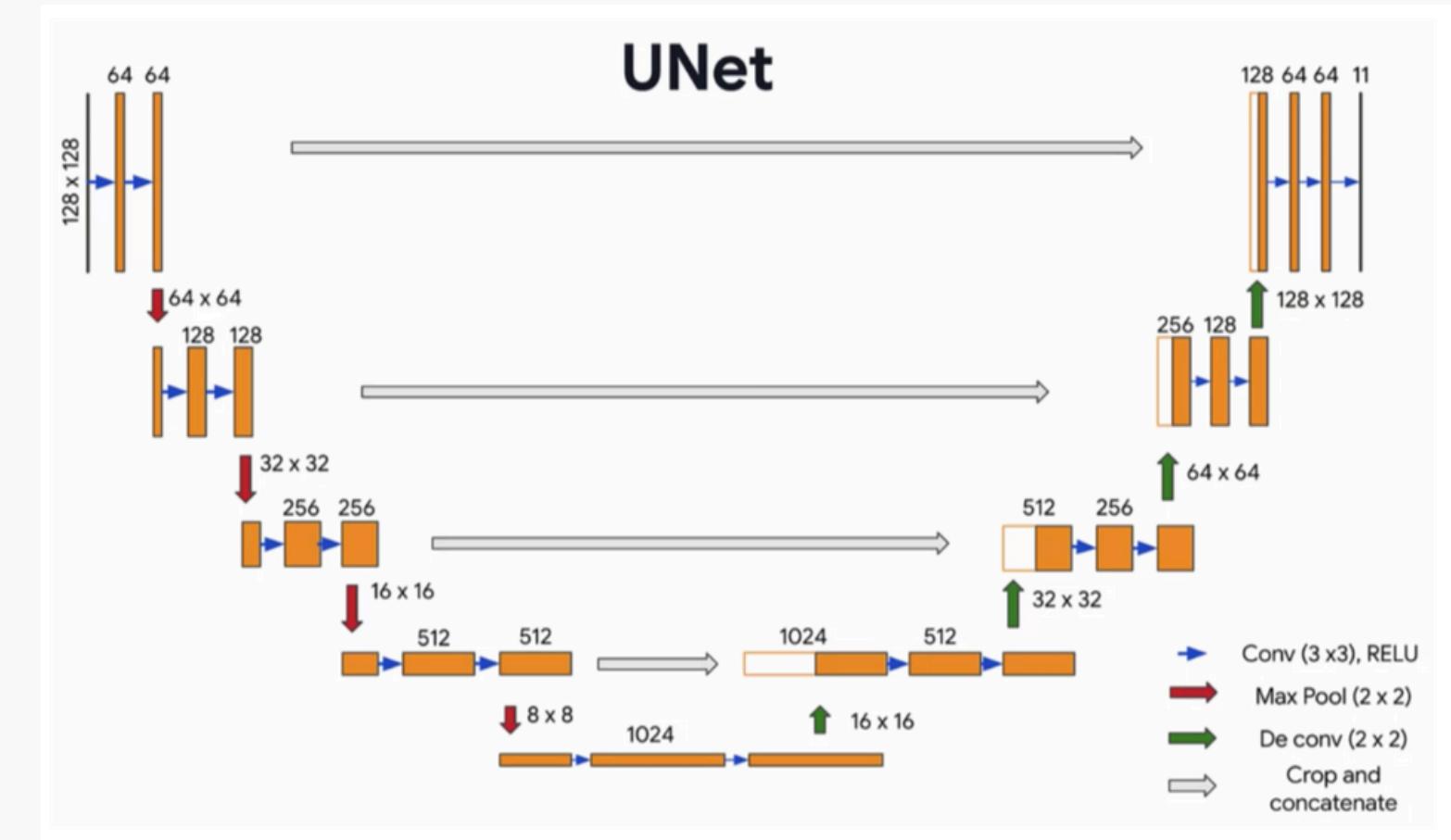


Proposed AI Solution

A full-stack DR diagnosis pipeline with a novel Artifact Remover using U-Net-based image fusion, leading to robust and explainable predictions.

Key Components:

- Patient Data Ingestion (Clinical Notes)
- SQLite-backed AI Agent for effective mapping
- DR Severity Classification (VLM model)
- Macular Edema Identification
- ICD Code Prediction
- Grad-CAM Explanation
- **Artifact-Free Image Generator**



Artifact Remover Model

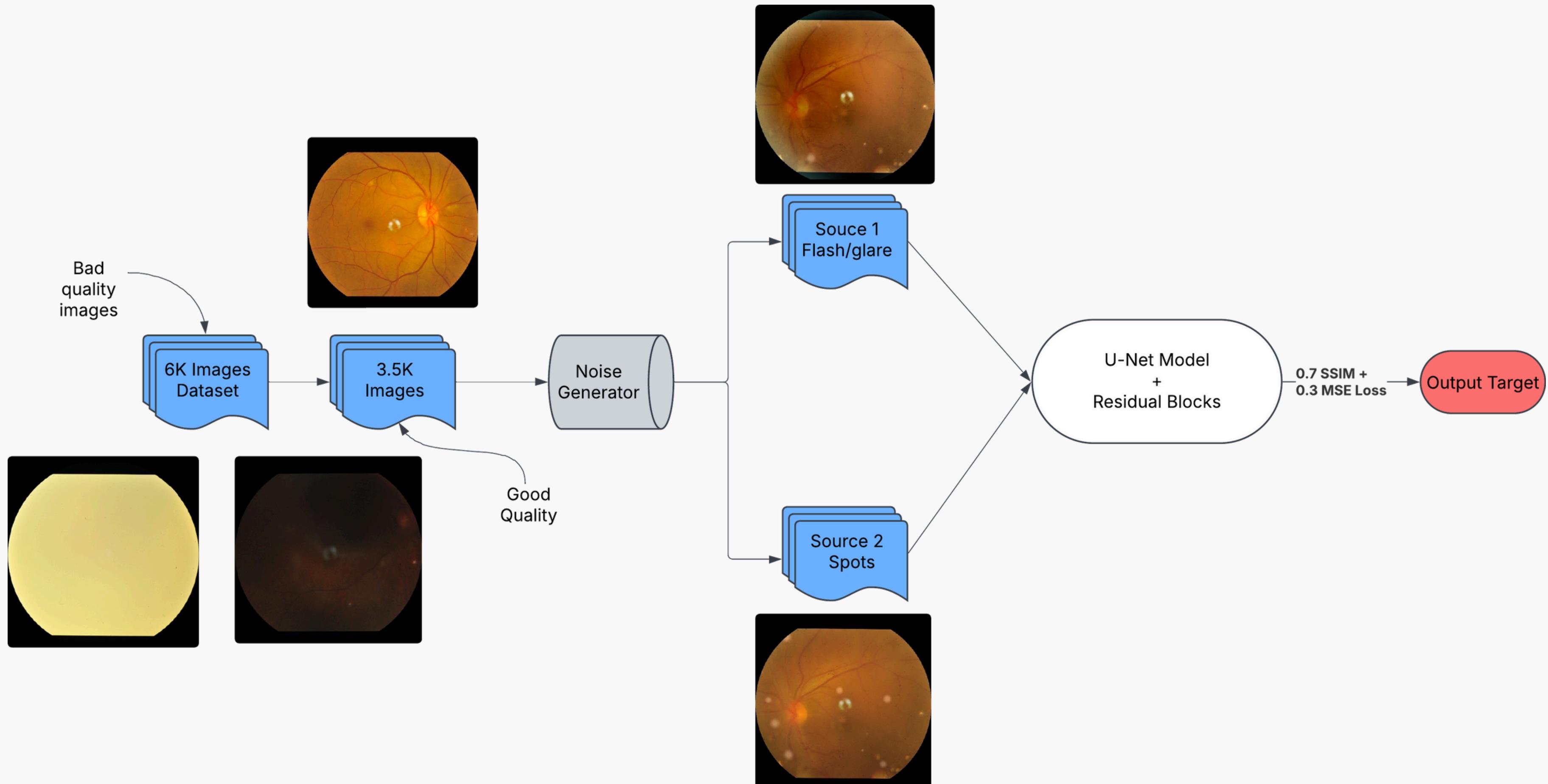
Key Innovation: Artifact Removal via Image Fusion

Logic: Artifacts are randomly introduced due to capture error; same eye retaken gives different locations of artifacts.

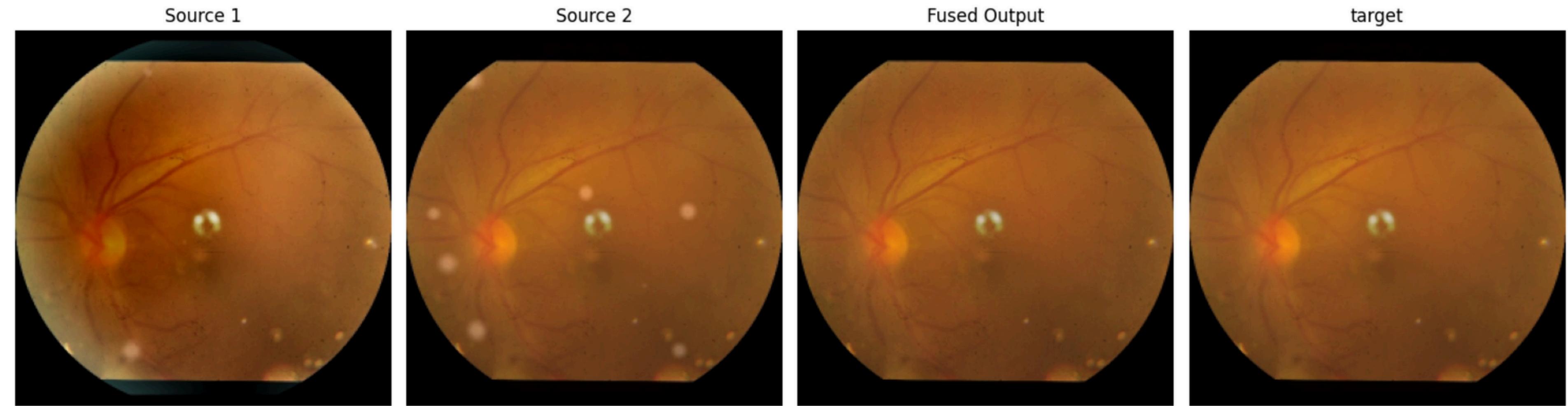
Solution:

- Take 2 fundus images of the same eye.
- Fuse "artifact-free" regions using ***U-Net with Residual Blocks***.
- Improves image quality without hallucination.

Architecture



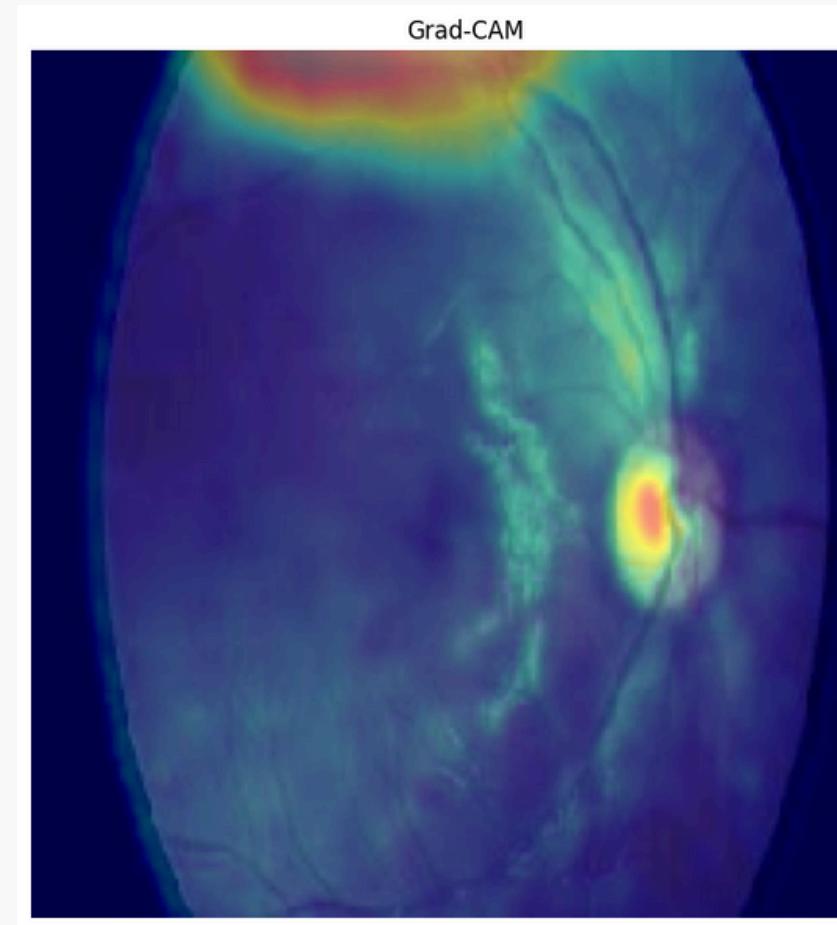
Result



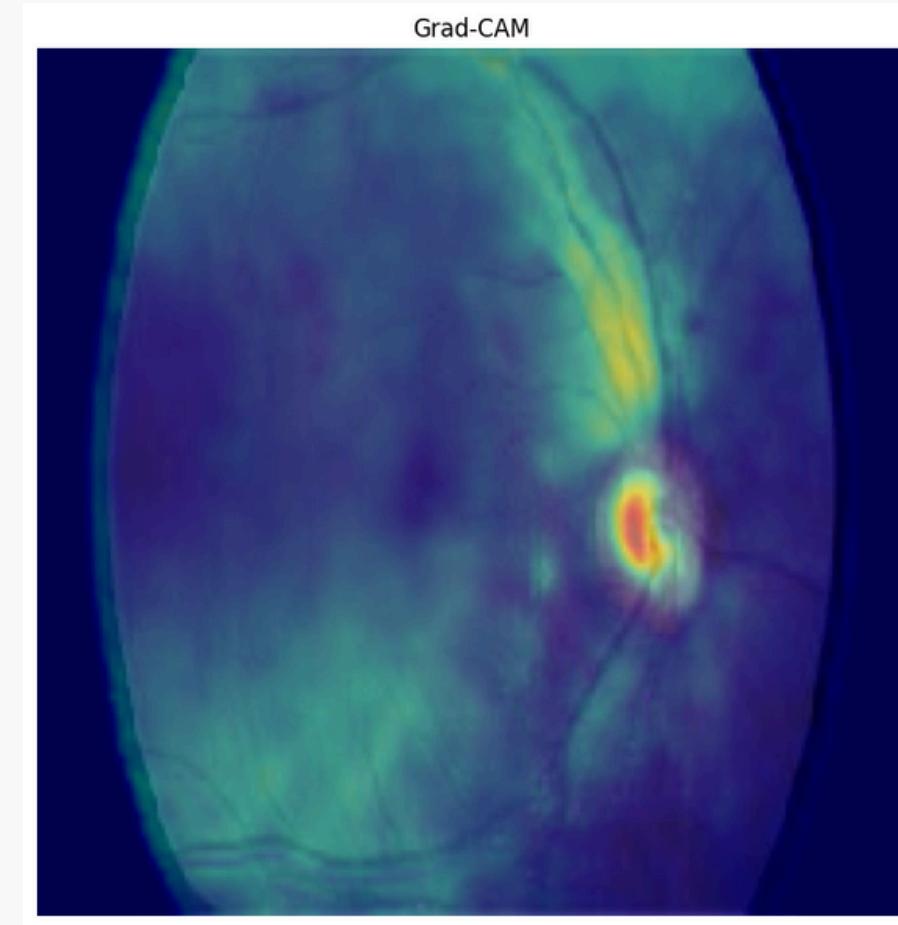
MSE loss : 0.0012
SSIM loss: 0.0322

Results & Grad-CAM Comparison

Predicted:Mild DR



Predicted>No DR



Before Artifact Removal:

- Model attention focused on glare/flash areas
- Reduced classification accuracy

After Artifact Removal:

- Attention shifted to actual retinal features
- Improved severity/disease detection
- Quantitative & visual proof included in demo (Grad-CAM images)

Why U-Net?

- Preserves anatomical structure.
- Enables pixel-level explainability unlike Transformer-based methods.

Why not Transformer-based Fusion?

- Lack explainability
- Higher compute cost
- Generates image from scratch → risk of hallucination
- U-Net allows a little medical interpretability: "Its cropping and fusing"

✗ UK NHS Screening Policy (Reference: Diabetic Eye Screening Programme)

- The UK's national DR screening program automatically rejects low-quality images and refers patients for repeat capture – increasing delays and costs.



Performance Boost With Artifact Removal (Study)

Study/System	Artifact Removal	AUC	Sensitivity	Specificity
Nookala et al. (2022)	No	0.82	85.3%	72.1%
	Yes (U-Net Masking)	0.89	91.2%	81.6%

✗ But

- Uses only 1 image – model infers missing regions, risking **hallucinated features**

Expected Impact

Clinical Value:

- Accuracy improvement in DR severity detection on artifact-prone images.
- More reliable reports for ophthalmologists and improved screening efficiency.
- Trustworthy AI adoption in low-resource clinical settings.

Real-World Applicability:

- Since we use Volk handheld cameras instead of fixed tabletop machines, image quality is more susceptible to human errors like hand shake, glare, or poor focus.
- The Artifact Remover model compensates for these challenges, enabling field-level deployment without compromising diagnostic accuracy.

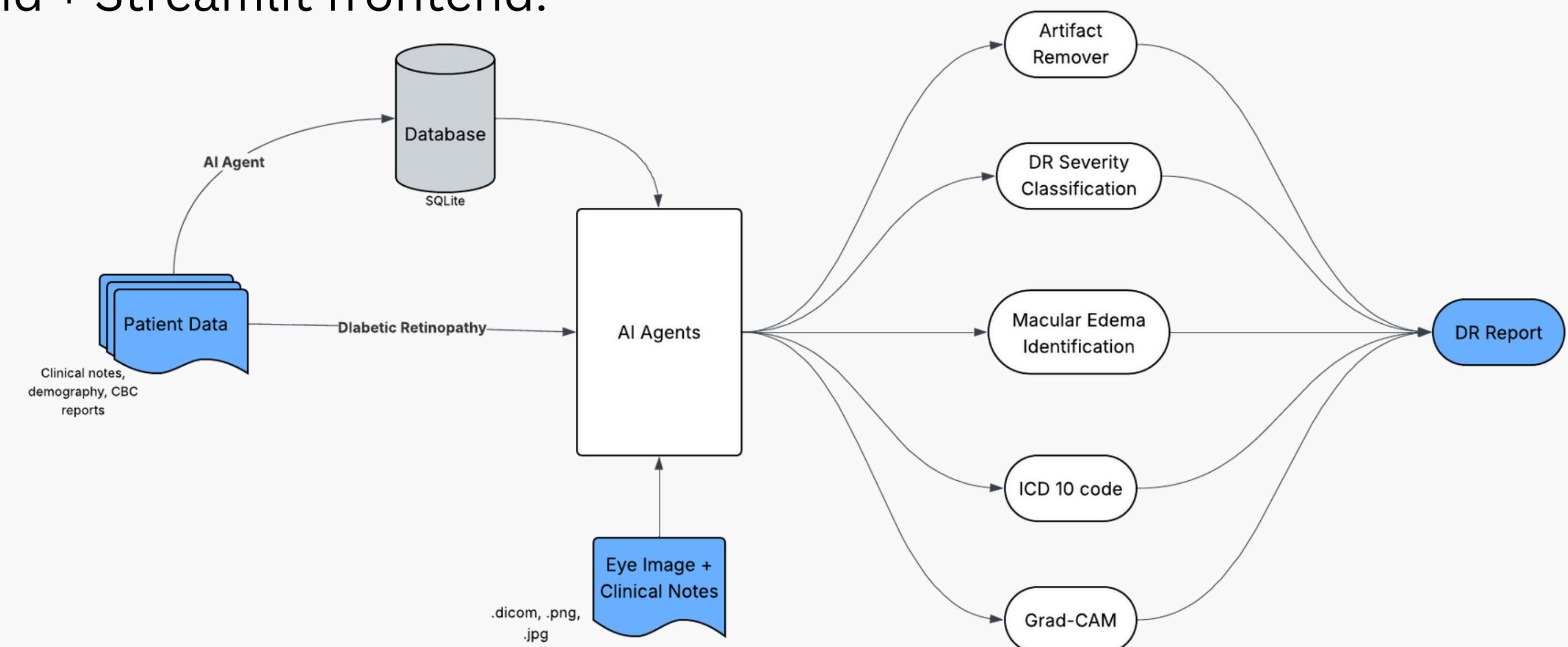
Scalability:

- Easily integrated into existing DR screening centers.
- Minimal hardware change needed—only a second image per eye from the handheld device.

Technical Approach

Model Highlights:

- U-Net (with Residual Blocks) for artifact fusion.
- VLM models for DR classification.
- Grad-CAM for interpretability.
- SQLite-based backend + Streamlit frontend.



Chennai Hospital

EyeScreenService
Diabetic Retinopathy Screening Report

Patient Information

Patient ID: 5
Patient Name: Iyu
Date of Birth: 1990-01-01
Gender: Male
Submission Date: 26-07-2025

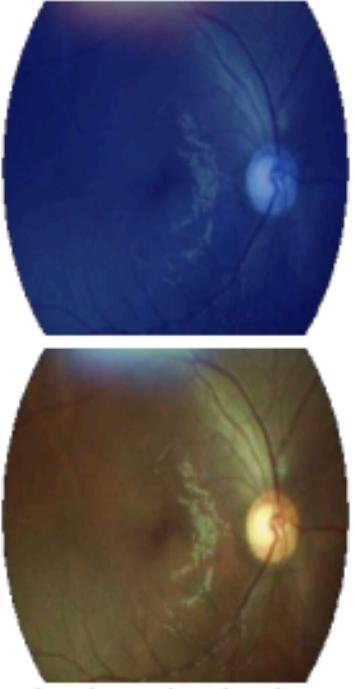
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Referring Provider:
Encounter ID:
Eyenuk Control ID:
Dilation Status:

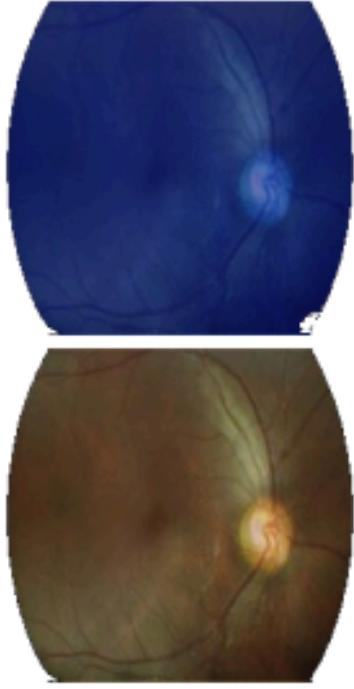
Diabetic Retinopathy Screening Summary

Screening Result: Negative for referable diabetic retinopathy.

Right Eye: NO DR



Left Eye: NO DR



*Do not use the above thumbnail images for diagnostic purposes.

ICD-10 Diagnosis Codes

: E11.9 Type Type 2 diabetes mellitus without complications
E11.9 Type Type 2 diabetes mellitus without complications

Plan and Recommendations

As per ADA recommendations, emphasize the importance of controlling blood sugar, cholesterol and bloodpressure as well the importance of routine follow-up with an ophthalmologist regardless of whether visual symptoms are present or absent.

Additional Comments

Left Eye: None
Right Eye: None

Digitally signed by
Report Date:

Chennai Hospital

EyeScreenService
Diabetic Retinopathy Screening Report

Patient Information

Patient ID: 13
Patient Name: Jenn
Date of Birth: 2015-07-29
Gender: Male
Submission Date: 26-07-2025

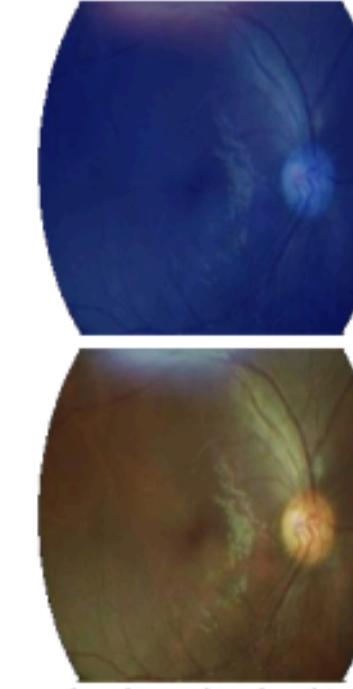
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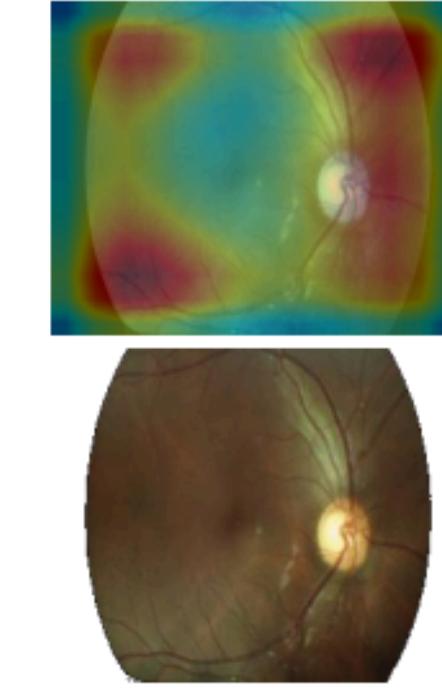
Diabetic Retinopathy Screening Summary

Screening Result: Positive for vision threatening diabetic retinopathy.

Right Eye: NO DR



Left Eye: Moderate DR



*Do not use the above thumbnail images for diagnostic purposes.

ICD-10 Diagnosis Codes

: E11.3312 Type Type 2 diabetes mellitus with moderate nonproliferative diabetic retinopathy with macular edema, left eye
E11.9 Type Type 2 diabetes mellitus without complications

Plan and Recommendations

As per ADA recommendations, emphasize the importance of controlling blood sugar, cholesterol and bloodpressure as well the importance of routine follow-up with an ophthalmologist regardless of whether visual symptoms are present or absent.

Additional Comments

Left Eye: None
Right Eye: None

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Report Date:

Demo & Final Notes

- Web-based DR Report Generation system implemented.
- ***Inputs:*** Patient data, retina images.
- ***Outputs:*** DR report PDF with results, Grad-CAM, ICD codes.

Innovation Summary:

- Artifact removal boosts AI explainability and reliability – a critical step for deploying DR models in the real world.