Technical Brief: Deep Learning System for Eye Disease Classification

This document is a technical brief detailing the design, implementation, and performance of a deep learning system for classifying five classes of eye conditions from ocular images.

Dataset:
Image Dataset on Eye Diseases Classification with Symptoms and SMOTE Validation

Classifications:
(Uveitis, Conjunctivitis, Cataract, Eyelid, Normal)

Algorithmic and System Design

Component	Implementation
Model Architecture	ResNet-18 (Transfer Learning) fine-tuned using a differential learning rate strategy for optimal convergence on the specialized image dataset.
Scientific Data Handling	Custom data utilities enforce aspect-ratio preserving preprocessing and training-set-only normalization to maintain image fidelity and eliminate data leakage.
MLOps & Reproducibility	MLflow integration for full experiment traceability and parameter logging. Evaluation uses a separate 'study' dataset for unbiased final metrics
Application & Deployment	Deployed via a Gradio UI featuring Softmax confidence scores and a Data Feedback Logging Loop for continuous data collection.

Quantitative Performance (On Held-Out Study Dataset)

The model was validated against a completely unseen dataset. The performance metrics confirm high accuracy and balanced classification across all disease categories.

Metric	Result	Interpretation
Accuracy (Overall)	95.26%	High general predictive power on unseen data.
Macro F1-Score	93.82%	Confirms uniform reliability across all five disease classes, essential for multi-class medical systems.
Macro Recall	94.17%	High rate of successfully identifying actual disease cases.

Confusion Matrix Analysis:

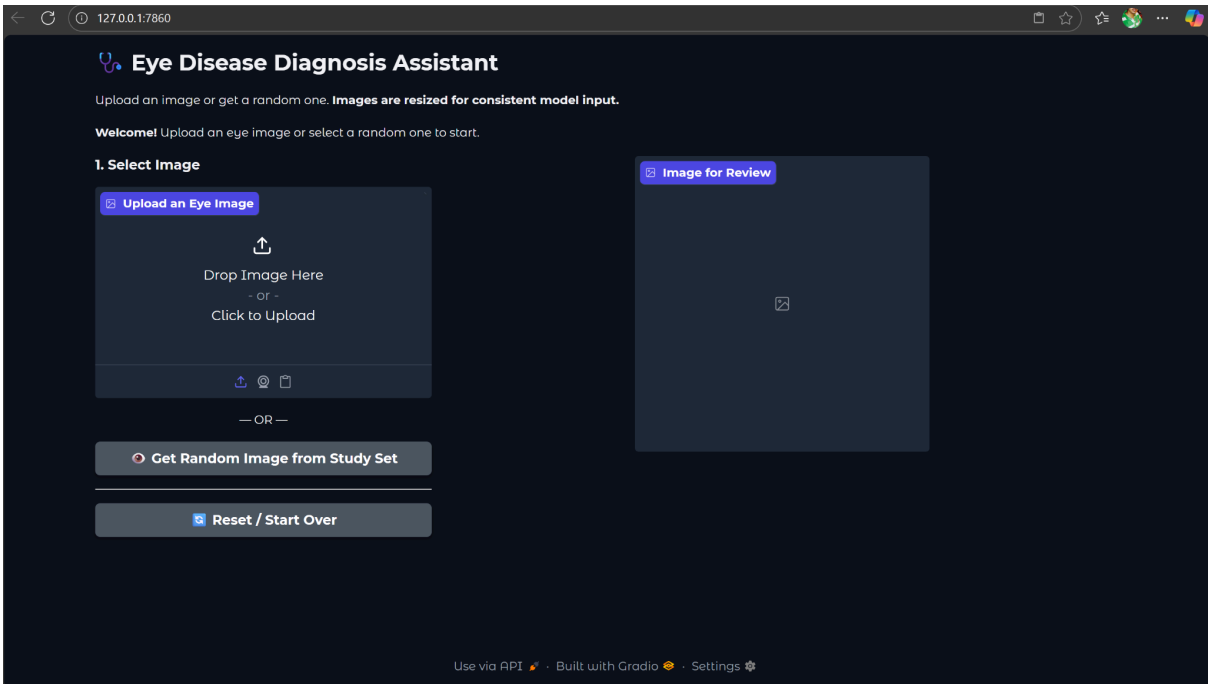
The model shows strong classification boundaries, achieving a **0% false positive rate for the 'Normal' class** (65/65 correct), indicating high specificity.

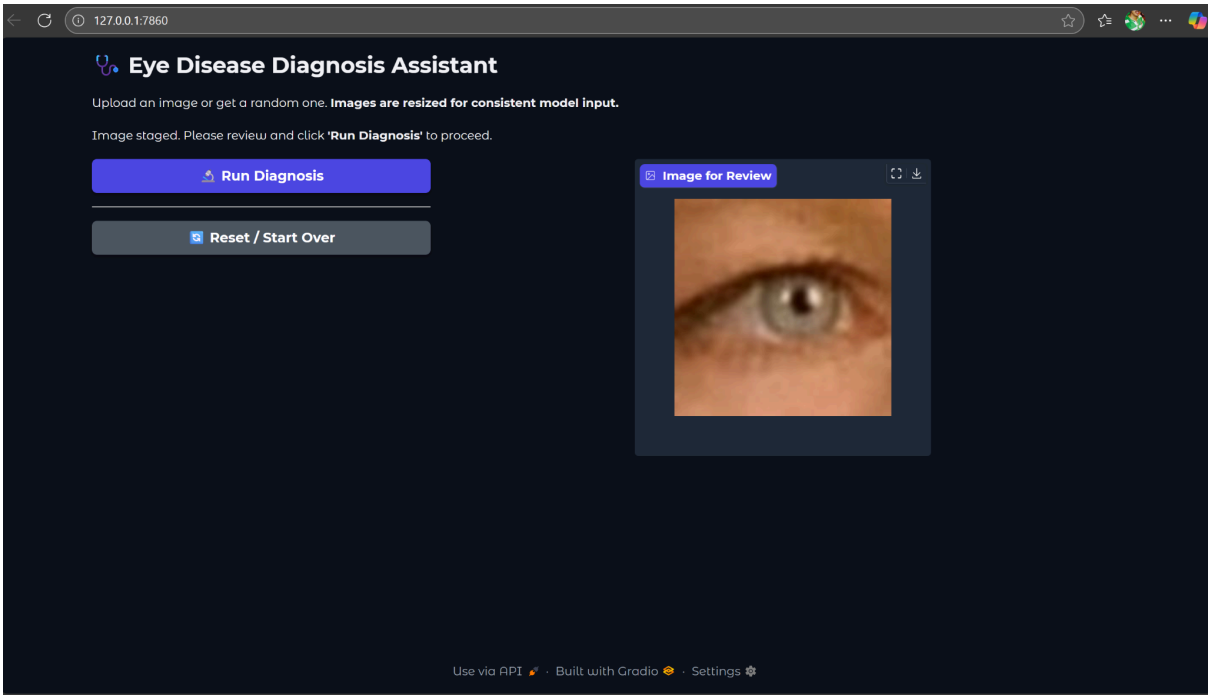
Actual/Predicted	Cataract	Conjuc.	Eyelid	Normal	Uvetis
Cataract	54	-	1	-	-
Conjunc.	1	32	1	-	2
Eyelid	-	1	49	-	3
Normal	-	-	-	65	-
Uvetis	-	-	2	-	21

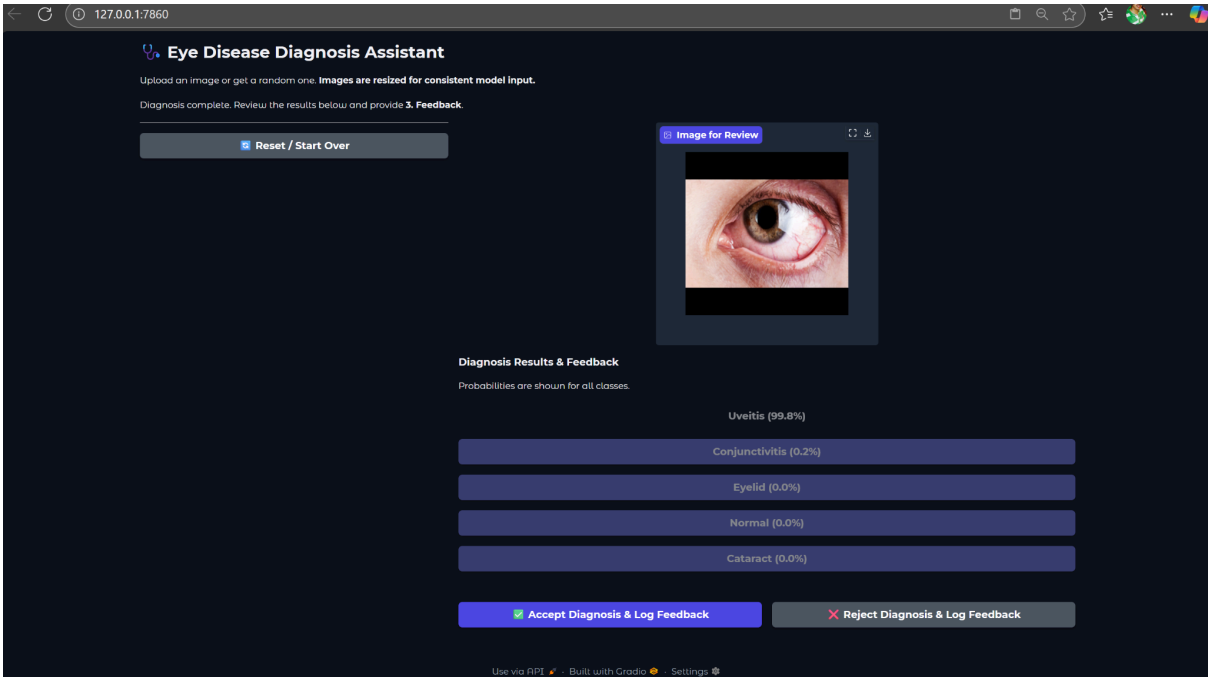
Application Workflow/UI:

The user interface demonstrates the system's readiness for real-world use through a simple, three-step user flow:

1. Image Staging	The image is loaded and pre-processed using the aspect-ratio preserving logic, ensuring input consistency with the trained model.
2. Diagnosis Output	The output displays the predicted class and the full Softmax confidence scores for all classes, providing necessary transparency.
3. Data Feedback	Includes a feedback mechanism (Accept/Reject) to log new, human-labeled data into separate directories for future model retraining.







GitHub Repository: [arshiv-web/eye_disease_detection: eye_disease_detection]