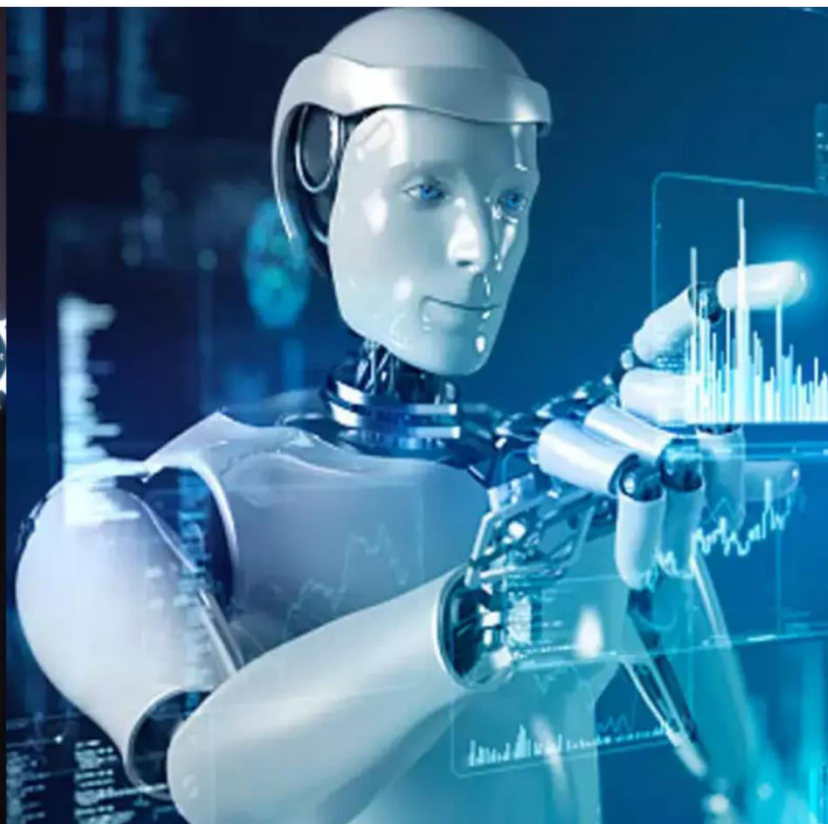




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Transforming Diabetic Retinopathy Detection with Inception V3-AT for Blindness Prevention

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ABSTRACT: Diabetic Retinopathy (DR) is A leading factor contributing to loss of vision worldwide, highlighting the critical need for early and accurate diagnosis to prevent blindness. This project proposes an automated, high-accuracy DR detection system using Inception V3-AT, a deep learning-based architecture. The methodology begins with preprocessing retinal fundus images using a median filter to reduce noise and enhance quality. Adaptive thresholding and clustering techniques are then applied for effective segmentation of significant retinal regions. Relevant features are extracted and fed into the Inception V3-AT model, which classifies the severity levels of DR with high precision. The system successfully distinguishes between normal and diseased images, enabling timely and reliable diagnosis, ultimately improving patient outcomes.

KEYWORDS: Diabetic retinopathy; Blindness risk; k-means; V3-AT Introduction

I. INTRODUCTION

Diabetic Retinopathy (DR) persists as a significant cause of blindness, particularly in diabetic populations lacking access to specialized care. This project introduces an advanced Attention-based Deep CNN (Convolutional Neural Network) (Attention-DCNN) to enhance the accuracy and efficiency of DR diagnosis, addressing the limitations of conventional screening methods in underserved regions. By integrating intelligent diagnostic systems into routine eye care, this approach enables timely and automated detection, reducing the burden on healthcare providers and supporting early intervention. The proposed system not only strengthens clinical decision-making but also has the potential to significantly boost treatment effectiveness and public health by preventing avoidable vision loss.

II. DIABETIC RETINOPATHY DETECTION

Diabetic Retinopathy (DR) is a progressive eye disease that occurs in individuals with diabetes due to prolonged Elevated blood glucose levels harms the small blood vessels in the retina — the light-sensitive layer at the back of the eye that enables vision. As these vessels become fragile, they may leak blood or fluid, resulting in swelling, retinal damage, and eventually vision loss. DR develops gradually, starting with mild non-proliferative stages characterized by microaneurysms, then progressing to moderate and severe stages with increasing vessel blockage and leakage. In the most advanced stage, proliferative diabetic retinopathy, the retina develops Pathological new blood vessels that can bleed into the eye, cause scar tissue, and lead to retinal detachment or permanent blindness. Affecting the macula, which causes diabetic macular edema (DME), where fluid accumulates in the macula, causing central vision distortion. Since DR often presents no symptoms in the early stages, regular eye examinations are essential for early detection and treatment. Risk factors include Diabetes duration period, poor blood sugar control, high blood pressure, and cholesterol levels. While treatments such as laser therapy, anti-VEGF injections, and vitrectomy can help prevent vision loss, early diagnosis is key. In this context, automated systems powered by deep learning, like Inception V3-AT, offer a promising solution for early and accurate DR screening, especially in underserved regions lacking specialist care.

III. PROPOSED METHODOLOGY

The system processes retinal fundus images through a structured pipeline for automated Diabetic Retinopathy classification. Median filtering is applied To increase visual quality and suppress noise. Segmentation is performed using adaptive thresholding, followed by clustering to isolate critical retinal regions. From these segmented regions, Boundary features are utilized to extract key features, which are then mapped and input into the InceptionV3-AT model. The model accurately classifies images into DR severity levels, enabling efficient diagnosis and supporting timely medical intervention. The proposed methodology For the diagnosis of Diabetic Retinopathy (DR) involves the development of an automated deep learning system using the Inception V3 model integrated with an attention mechanism (Inception V3-AT). The process begins with the collection of retinal fundus images from publicly available datasets such as APTOS or EyePACS, covering multiple classes including normal, mild, moderate, severe, and proliferative DR. Preprocessing steps are applied To increase visual quality, including resizing, contrast adjustment, noise reduction, and data augmentation to improve model robustness and performance. The enhanced Inception V3-AT model is then trained on these images, where the base Inception V3 network handles deep feature extraction, and the attention module enables the model to focus on clinically relevant regions such as microaneurysms and haemorrhages. Each image is labeled with its corresponding category, including glaucoma, normal, and diabetic retinopathy. These images showcase the visual characteristics associated with different ocular conditions, which are crucial for training and evaluating automated diagnostic systems

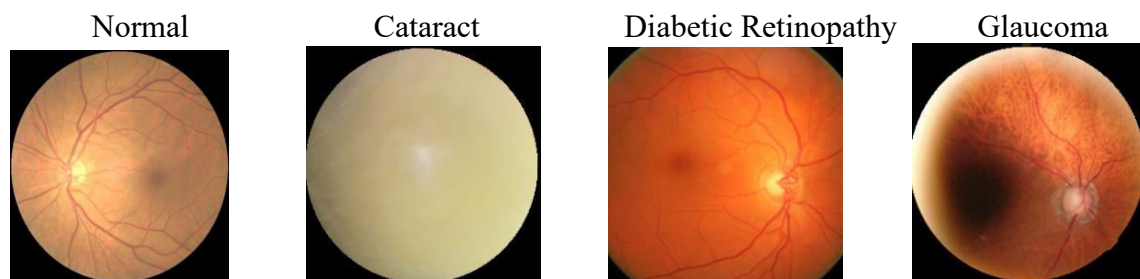


Fig 1 Sample Images from Retinal Disease Dataset

Figure 1 displays a selection of fundus photographs from a dataset used for retinal disease classification. Retinal image classification includes four main classes: Normal, showing a healthy retina with clear structures; Cataract, causing blurry images due to lens clouding; Diabetic Retinopathy, marked by retinal damage like microaneurysms and hemorrhages; and Glaucoma, identified by optic nerve damage such as an enlarged optic cup. Accurate classification helps in early detection and vision loss prevention.

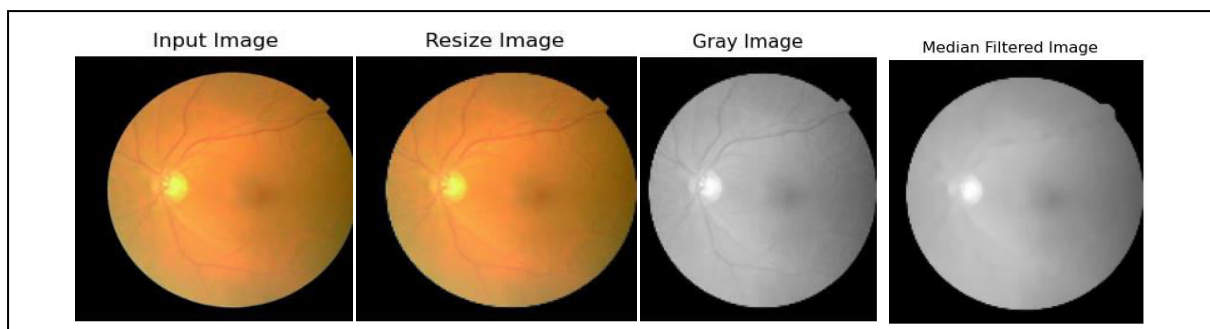


Fig 2 Preprocessing

Figure 2 illustrates the process of resizing a retinal fundus photograph, a common preprocessing step for training neural networks. The left panel shows the original "Input Image," while the right panel displays the "Resize Image," which has been adjusted to a consistent size. Image resizing ensures uniformity in input dimensions, which is essential for the efficient processing by deep learning models. These images are crucial for diagnosing various eye conditions. A median filter is applied to the grayscale image. This process helps reduce noise while preserving edges, enhancing the visibility of retinal structures

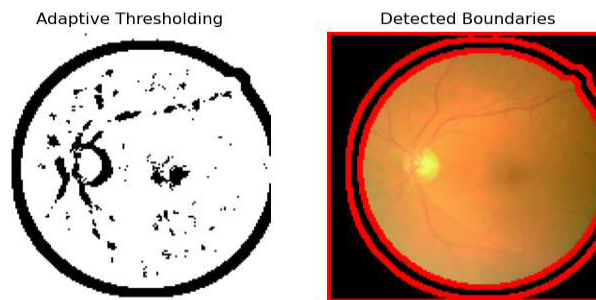


Fig 3 Boundary Detection in Retinal Image

Figure 3 left images is the result of adaptive thresholding on a retinal fundus. The right image shows the original color retinal image with detected boundaries overlaid in red. This process helps delineate the optic disc and other significant structures within the retina. The validation loss 0.041 and validation accuracy 0.988 of a machine learning model. The validation loss is approximately 0.0416, indicating a low error rate on unseen data.

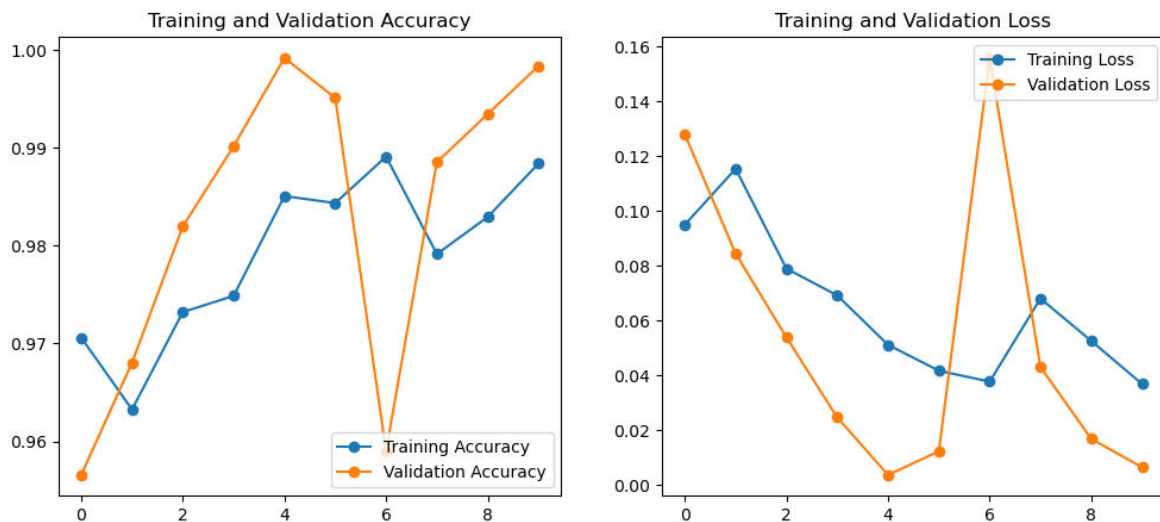


Fig 4 Training and Validation Performance

Figure 4 graph illustrates the accuracy on training and validation datasets of a model over epochs. Both accuracies generally increase, with the validation accuracy showing some fluctuations. The right graph displays the accuracy on training and validation datasets the validation loss initially decreases but then exhibits a spike, suggesting potential over fitting around that epoch.

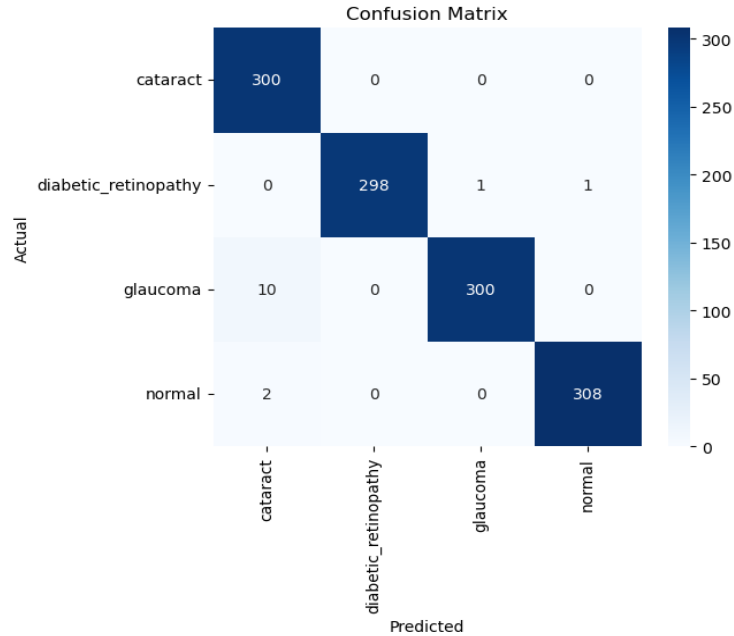


Fig 5 Confusion Matrix

Figure 5 confusion matrix visualizes the effectiveness of a classification model. The columns represent the predicted classes. The diagonal values denote the correct classification counts predictions for each class, and the off-diagonal elements indicate the number of misclassifications. For instance, 10 glaucoma cases were incorrectly predicted as cataract.

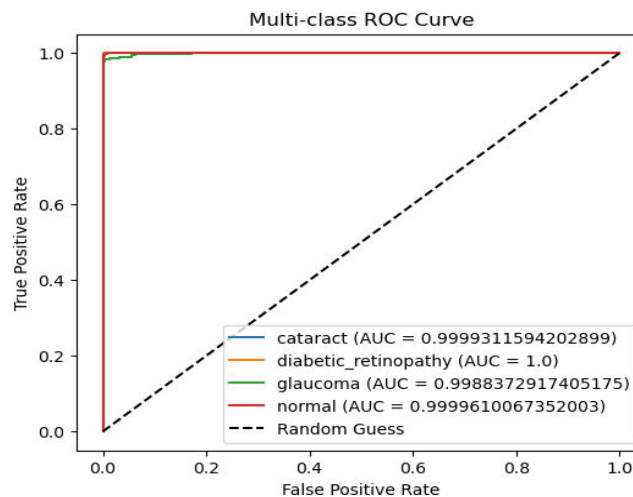


Fig 6 Multi-class ROC Curve

Figure 6 displays Performance curves based on Receiver Operating Characteristic analysis for each class (cataract, diabetic retinopathy, and glaucoma, normal) in a multi-class classification problem. A graph is created by plotting the True Positive Rate against the False Positive Rate across a range of thresholds.

IV. SIMULATION RESULTS

The performance of the proposed Inception V3-AT model was evaluated using a labeled dataset of retinal fundus images. The suggested deep learning model based on the Inception V3-AT architecture was trained and evaluated on a multi-class dataset comprising four categories of retinal fundus images: Cataract, Diabetic Retinopathy (DR), Glaucoma, and Normal.

RETINAL DETECTION

Upload an image to get predictions for each class.

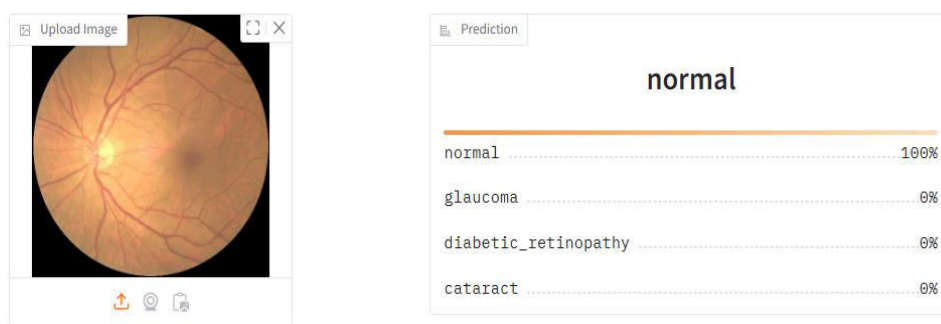


Fig 7 Predicted Normal Retinal image

Figure 7 illustrates retinal fundus image that has been analyzed by a model. The text at the bottom indicates that the predicted class for this image is "Normal Retinal image ". This suggests the model has identified features within the image consistent with this eye disease. A normal retinal image represents The visual aspect of a healthy eye as captured through fundus photography, showing no signs of diabetic retinopathy or other pathological changes. There are no visible abnormalities such as Micro aneurysms (small red dots), Hemorrhages (bleeding spots), Exudates (yellowish lipid deposits), Cotton wool spots or neovascularization, Cataract Retinal Image.

RETINAL DETECTION

Upload an image to get predictions for each class.

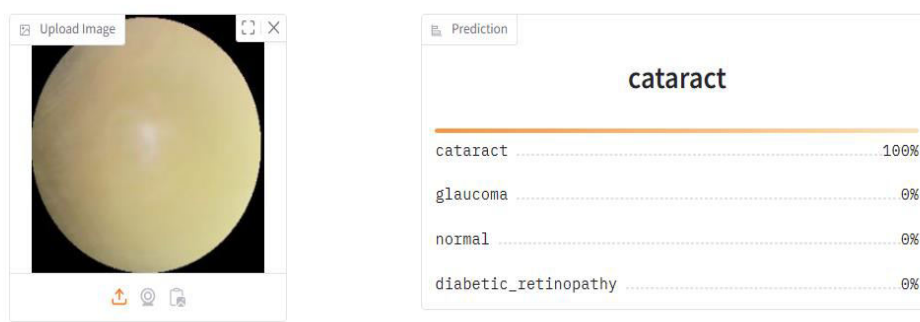


Fig 8 Predicted Cataracts

Figure 8 illustrates retinal fundus image that has been analyzed by a model. The text at the bottom indicates that the predicted class for this image is "Cataract ". This suggests the model has identified features within the image consistent with this eye disease. Blurry appearance of retinal structures (optic disc, macula, blood vessels) Low contrast and poor illumination. Loss of detail in critical regions Owing to the scattering of light. Increased noise, making it harder for both humans and AI models to detect subtle DR signals. Diabetic Retinopathy Retinal Image

RETINAL DETECTION

Upload an image to get predictions for each class.

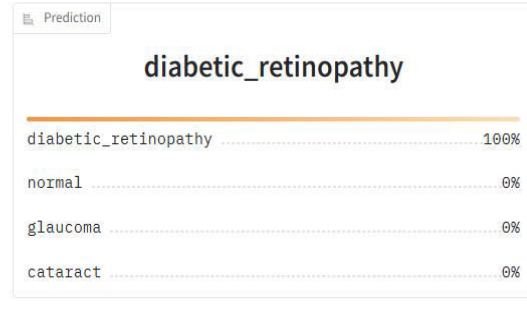
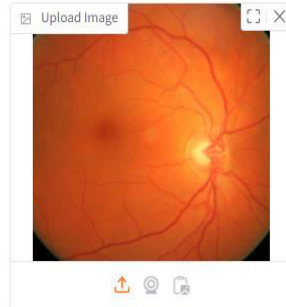


Fig 9. Predicted Diabetic Retinopathy

Figure 9 illustrates retinal fundus image that has been analyzed by a model. The text at the bottom indicates that the predicted class for this image is "diabetic retinopathy". This suggests the model has identified features within the image consistent with this eye disease. A diabetic retinopathy (DR) retinal image is a fundus photograph of the retina that exhibits characteristic pathological changes resulting from prolonged increased blood sugar concentration in diabetic patients. Diabetic retinopathy results from damage to the small blood vessels in the retina, resulting in several visible irregularities that can be detected in retinal images using clinical examination or deep learning-based methods.

RETINAL DETECTION

Upload an image to get predictions for each class.

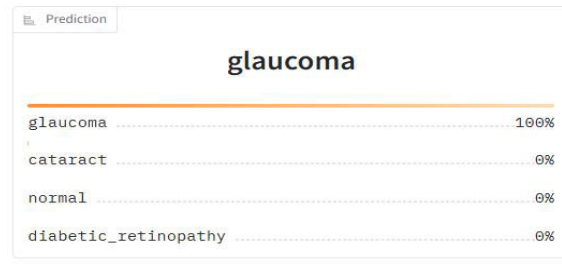
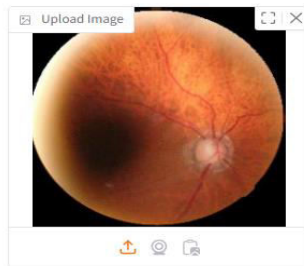


Fig10. Predicted Glaucoma

Figure 10 illustrates retinal fundus image that has been analyzed by a model. The text at the bottom indicates that the predicted class for this image is "Glaucoma ". This suggests the model has identified features within the image consistent with this eye disease.

Retinal Image	Existing System		Proposed system
	CNN Accuracy (%)	DCNN Accuracy (%)	INCEPTION V3-AT Accuracy (%)
Normal	88.5	91.2	95.6
Cataract	85.0	89.7	94.1
Diabetic Retinopathy	87.3	90.5	96.3
Glaucoma	86.7	90.0	94.8

Table.1 Retinal Image Classes Accuracy (%)

A glaucoma retinal image is a fundus photograph that reveals structural changes in the optic nerve head, often associated with increased intraocular pressure that can lead to progressive, irreversible vision loss. Unlike diabetic retinopathy, which Damages the blood vessels of the retina, glaucoma primarily damages the optic nerve, making early detection critical for vision preservation.

V. CONCLUSION

This work demonstrates the effectiveness of using the Inception V3-AT model for the early and accurate Identification of Diabetic Retinopathy. The approach combines median filtering, adaptive thresholding, and clustering techniques To increase the quality of the image and isolate significant regions of interest. Feature extraction is efficiently performed before classification, allowing the model to accurately identify various stages of DR. The system shows high reliability in distinguishing between normal and diseased retinal images, supporting timely medical intervention and contributing to the prevention of vision loss. The achieved results highlight the model's robustness and potential as a dependable diagnostic aid in clinical practice.

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