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Empowering Diabetic Retinopathy Detection with EfficientNet-B7 and GAN Augmentation

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ABSTRACT -

In today's fast-paced lifestyles, maintaining health and caring for aging parents are increasingly challenging, underscoring the importance of telemedicine for accessible and efficient healthcare. Diabetic Retinopathy (DR), a leading cause of blindness, demands innovative solutions for early detection and effective treatment. This study proposes a method combining EfficientNet-B7 with Generative Adversarial Networks (GANs) to enhance DR detection. EfficientNet-B7 classifies retinal images into various DR stages, while GANs generate synthetic images to address limited labeled data, augmenting the training dataset and improving model performance .The integrated approach improves the accuracy, reliability, and adaptability, making it ideal for clinical use. Integrating this method into telemedicine platforms improves healthcare accessibility in remote and underserved areas. This study highlights the transformative potential of machine learning in healthcare, providing a practical, technology-driven solution that reduces system burdens and improves patient outcomes.

Key Words: EfficientNet-B7, Generative Adversarial Networks (GANs), Deep Learning, Data Augmentation, Retinal Image Classification.

INTRODUCTION

Diabetic Retinopathy (DR) is a common and serious complication of diabetes mellitus and remains a leading cause of vision impairment and blindness across the globe. It results from damage to the blood vessels in the retina caused by prolonged periods of high blood sugar levels. These damaged vessels can leak fluid or blood, swell, or grow abnormally, leading to progressive retinal damage. DR typically develops gradually and progresses through different stages, starting from mild non-proliferative changes—such as microaneurysms—to moderate and severe non-proliferative stages, eventually advancing to proliferative diabetic retinopathy, where abnormal blood vessels grow and can cause significant vision loss. The progression is often asymptomatic in the early stages, which makes regular eye screening crucial for timely detection. Several risk factors contribute to the development and severity of DR, including poor glycemic control, long duration of diabetes, hypertension, hyperlipidemia, smoking, and genetic predisposition. If left untreated, DR can lead to complications such as macular edema, retinal detachment, or neovascular glaucoma, potentially resulting in irreversible blindness.

The importance of early detection and intervention in managing DR cannot be overstated. Treatments such as laser photocoagulation, intravitreal injections of anti-VEGF (vascular endothelial growth factor) agents, and surgical procedures like vitrectomy can slow disease progression and prevent vision loss when administered at the right time. However, in many low-resource settings, access to ophthalmic care is limited, and awareness about regular screening remains low. This creates a pressing need for scalable, accurate, and accessible diagnostic solutions. In recent years, artificial intelligence (AI) has emerged as a transformative tool in addressing this challenge. Specifically, deep learning techniques like Convolutional Neural Networks (CNNs) have shown remarkable success in the automated classification of retinal fundus images, identifying subtle features associated with different DR stages with high precision. Advanced CNN models, such as EfficientNet, have proven highly effective due to their ability to balance network depth, width, and resolution, enabling robust feature extraction from medical images while maintaining computational efficiency. In addition to classification, Generative Adversarial Networks (GANs) have been leveraged to enhance the training datasets by generating synthetic but realistic retinal images. This approach helps to address issues like class imbalance—where certain stages of DR are underrepresented in the training data—and limited access to labeled medical images. By enriching the dataset with diverse and high-quality synthetic images, GANs improve model generalization and reduce the likelihood of overfitting. This combination of EfficientNet for classification and GANs for data augmentation offers a powerful AI-driven framework for DR detection, especially valuable in telemedicine and mobile health applications. Moreover, these technologies support explainability features such as Grad-CAM, which helps visualize the areas of interest in retinal images that influence the model's predictions, building trust among clinicians. As AI continues to evolve, its integration into clinical workflows promises to enhance early detection, support timely treatment, and ultimately reduce the global burden of diabetic retinopathy, particularly in underserved and remote regions.

LITERATURE SURVEY

The authors develop a deep learning-based model for Diabetic Retinopathy (DR) detection using InceptionV3 with transfer learning on EyePACS and APTOS 2019 datasets. Data augmentation addresses class imbalance across five DR severity levels. The model achieves 74.28% accuracy (EyePACS) and 81.61% accuracy (APTOS), proving its clinical potential. However, performance varies due to dataset quality and generalization limits [1].
Another study employs ResNet50 with transfer learning to improve DR classification on the APTOS 2019 dataset (3,662 images). Validation accuracy reaches up to 87.76%, with evaluations done via confusion matrices. Despite data scarcity and over fitting risks, the model shows promise for real-world medical screening applications [2].

PROPOSED SYSTEM

There are numerous tools available for making DF, however, there are few for detecting DF. Our approach to detecting the DF will make a significant contribution to preventing the DF from spreading over the internet. We will provide a web-based platform for users to post videos and determine if they are fake or real. This project can be expanded from creating a web-based platform to creating a browser plugin for automatic DF detection. Even large applications like WhatsApp and Facebook can integrate this project into their applications to easily identify DF before sending it to another user. One key goal is to assess its performance and acceptability in terms of security, usability, correctness, and reliability. Our technique is designed to detect all types of DF, including replacement, retrenchment, and interpersonal DF. Figure 1 depicts the proposed system's simple system architecture: -

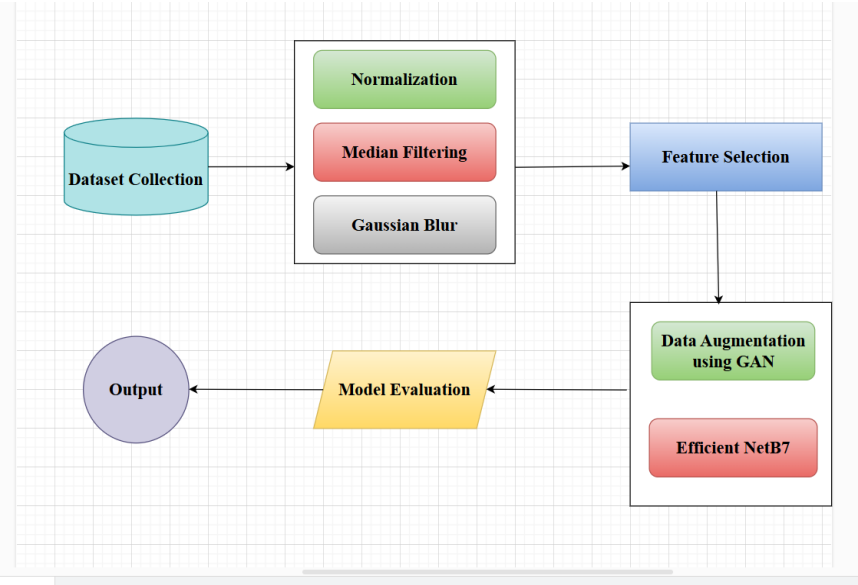

Fig. 1: System Architecture

A. *Dataset:*

The first step in this methodology is the collection of retinal fundus images from Kaggle, a widely used platform for medical image datasets. These images are labeled based on the severity of Diabetic Retinopathy (DR), ranging from mild to severe cases. Since medical datasets often suffer from class imbalances, ensuring a diverse and representative dataset is crucial for training a deep learning model that can generalize well to new cases.

B. *Preprocessing:*

Before training the deep learning model for diabetic retinopathy (DR) detection, preprocessing enhances image quality for better feature extraction. It involves normalization to standardize brightness and contrast, median filtering to reduce noise while preserving retinal features, and Gaussian blur to smooth background artifacts. These steps highlight key pathological features, improving the model's accuracy in detecting and classifying DR stages.

C. *Model:*

The model uses GANs for augmenting imbalanced data and EfficientNet-B7 for classifying diabetic retinopathy. GANs generate realistic synthetic images, improving dataset diversity, while EfficientNet-B7 extracts key features with high accuracy and efficiency, making the system robust and suitable for real-world DR detection.

D. *CNN for Feature Extraction:*

We suggest using A CNN-based model like EfficientNet is used to extract key retinal features for diabetic retinopathy detection. By fine-tuning layers and optimizing the learning rate, the model effectively captures clinical signs such as microaneurysms and hemorrhages from high-dimensional feature vectors, enabling accurate stage classification.

E. GAN for DataAgumentation:

Generative Adversarial Networks (GANs) significantly enhance diabetic retinopathy (DR) detection by addressing class imbalance and limited data issues in medical imaging. By generating realistic synthetic retinal images, GANs expand and diversify training datasets, ensuring balanced representation of all DR severity levels and improving model robustness. The Generator creates images, while the Discriminator evaluates their authenticity, enabling high-quality synthetic image generation that mimics real fundus features like hemorrhages and exudates. This not only aids in model generalization and reduces overfitting but also preserves patient privacy by producing non-identifiable data. GANs can also support anomaly detection, enable unsupervised learning, and integrate with multi-modal data for comprehensive diagnostics, making them a valuable tool in AI-driven DR screening and clinical decision-making.

F. *EfficientNet-B7 for Classification:*

EfficientNet-B7 excels in diabetic retinopathy (DR) detection due to its multi-scale feature extraction and balanced compound scaling, allowing it to capture both fine and large retinal abnormalities. Its Squeeze-and-Excitation (SE) blocks improve focus on critical features, making it robust against varying image quality. When combined with GAN-based augmentation, the model handles class imbalance effectively, improving generalization and performance on rare DR cases. Pretrained on ImageNet, EfficientNet-B7 benefits from transfer learning, reducing training time and enhancing accuracy with limited data. Its integration with Grad-CAM supports model interpretability, aiding clinical trust. Its efficiency makes it ideal for scalable deployment, even on low-resource devices or in federated learning settings. Adding attention mechanisms like transformers can further boost its accuracy and early-stage DR detection.

RESULT

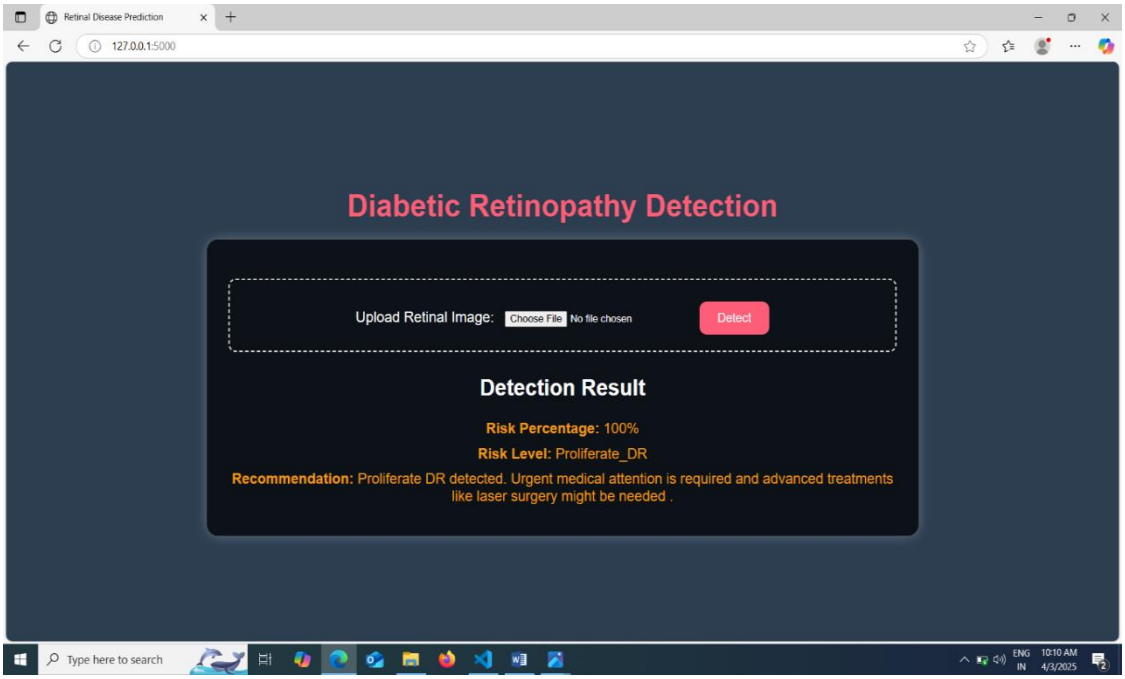

Figure 4.5: PROLIFERATE_DR

CONCLUSION :

This project successfully demonstrates the use of EfficientNet-B7 and Generative Adversarial Networks (GANs) for improving diabetic retinopathy (DR) detection. EfficientNet-B7 is a deep learning model that accurately identifies retinal abnormalities like microaneurysms and hemorrhages. GANs help generate synthetic images, increasing the dataset size and improving model performance. By combining these techniques, the model achieves high accuracy and can handle diverse patient data. This approach reduces overfitting and enhances generalization, making it reliable for real-world applications. Automated DR detection can assist doctors by enabling early diagnosis and timely treatment. It helps reduce the workload in hospitals and makes screening more efficient. Future improvements and clinical Testing will ensure better adaptability to real-world medical conditions.

REFERENCES

[1]. Deshpande, G., Govardhan, Y., & Jain, A. (2024, January). Machine Learning-Based Diabetic Retinopathy Detection: A Comprehensive Study Using InceptionV3 Model. 994-999. IEEE.

[2]. Dasari, S., Poonguzhali, B., & Rayudu, M. (2023, November). Transfer Learning Approach for Classification of Diabetic Retinopathy using Fine-Tuned ResNet50 Deep Learning Model. IEEE Access . 1361-1367.

[3]. Nandhini, S., Sowbarnikkaa, S., Mageshwari, J., & Saraswathy, C. (2023, May). An automated detection and multi-stage classification of diabetic retinopathy using convolutional neural networks. 7646-5435. IEEE.

[4]. Khalid, N., & Deriche, M. (2023, December). Combining CNNs for the Detection of Diabetic Retinopathy. IEEE Access, 9, 61408-61416

[5]. Matthew, A., Gunawan, A. A. S., & Kurniadi, F. I. (2023, November). Diabetic Retinopathy Diagnosis System Based on Retinal Biomarkers Using EfficientNet-B0 for Android Devices. 207-212. IEEE.