Detection of Diabetic Retinopathy Using CNN

1st Vara Siddha Vignesh Edara
Dept. of Computer Science
SRM University -AP

2nd Jayanth Bonthala
Dept. of Computer Science
SRM University -AP

3rd Uday Kiran Nathani
Dept. of Computer Science
SRM University -AP

4thSiva Chandra Prasad Panguluri
Dept. of Computer Science
SRM University -AP

5th Radha Abburi
Dept. of Electronics & Communication
SRM University -AP

6th Sibendu Samanta
IEEE Member, Dept. of ECE&CSE
SRM University -AP

***Abstract*—Among diabetic patients, Diabetic Retinopathy (DR) is one of the main causes of blindness; therefore, early and accurate detection is essential for successful treatments. Convolutional Neural Network, one type of deep learning technique, has demonstrated potential in automating the diagnosis of diabetic retinal disease using retinal pictures. We provide a new method in this paper for detecting diabetic retinopathy that makes use of the Inception Net architecture. Because of its reputation for processing high-resolution images efficiently, the Inception Net model is a good fit for the intricate tasks involved in retinal image analysis. We trained and assessed our proposed model using a large dataset of annotated retinal pictures, and it achieved high specificity, sensitivity, and accuracy in differentiating between retinas that were healthy and those that were diseased. According to our research, deep learning-based methods like Inception Net have a great deal of promise for the accurate and fast identification of diabetic retinopathy, which will lead to better patient outcomes and enable prompt clinical intervention.**

***Index Terms*—Deep Learning; CNN; Inception Net.**

I. Introduction

Diabetes-related retinopathy (DR) is a major global public health issue, especially for those with diabetes mellitus. If treatment for this progressive retinal illness is not received, it might result in blindness and visual impairment. As diabetes becomes more common, DR is one of the main avoidable causes of blindness in working-age adults. Preventing eyesight loss and enhancing patient outcomes need early detection and prompt management. However, the manual DR screening procedure is time-consuming, labor-intensive, and subject to variation amongst practitioners. Therefore, automated methods that can quickly and effectively identify diabetic retinopathy from retinal pictures are desperately needed to speed up the screening process and enable prompt intervention. Deep learning has become a potent instrument for medical image processing in recent years, with the potential to completely transform the discipline of ophthalmology. Convolutional neural network, in particular, are deep learning algorithms that have shown impressive performance in a variety of medical imaging applications, such as the identification and categorization of diabetic retinopathy. The Inception Net is one of the several deep learning architectures that are particularly effective at analyzing complex, high-resolution images. Our goal is to create a reliable and accurate system that can identify diabetic retinopathy from retinal scans by utilizing Inception Net's capabilities.

1.1 Diabetic Retinopathy: Diabetic retinopathy (DR) is a serious eye disease that can affect people with diabetes. It rises from high blood sugar levels damaging the blood vessels in the retina, the light-sensitive layer at the back of the eye. This damage can lead to a variety of problems. [2]

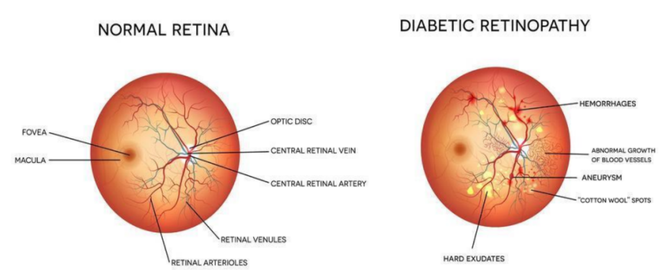

Fig. 1. Normal Retina vs Diabetic Retinopathy. The image compares healthy eye to an eye with diabetic retinopathy. The healthy eye includes a well-defined macula, the range mindful for central vision. The eye with diabetic retinopathy has damage to the macula, which can lead to vision loss.

1.2 Stages of Diabetic Retinopathy:

Mild Nonproliferative Retinopathy: This early stage may have no symptoms, but tiny bulges (microaneurysms) may appear in the retinal blood vessels.

Moderate Nonproliferative Retinopathy: More blood vessels become affected, and some may leak fluid or blood. Some people may experience blurry vision or floaters at this stage.

Severe Nonproliferative Retinopathy: Significant leakage and blockage of blood vessels occur, leading to vision problems like dark spots and blurry vision.

Proliferative Diabetic Retinopathy (PDR): This advanced stage is characterized by the growth of abnormal new blood vessels. These vessels are fragile and can bleed easily, causing severe vision loss or even blindness. [4]

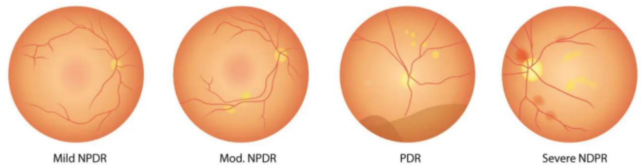

Fig. 2. Stages of Diabetic Retinopathy. The image shows four stages of diabetic retinopathy (DR), a diabetes complication that harms the eye's light-sensitive retina. As DR advances (from mild to severe), anomalies like bleeding and new blood vessels create, expanding chance of vision loss chance. Early detection is key to preserving sight.

II. LITERATURE SURVEY

CNN is a capable course of profound learning models particularly planned for picture examination assignments. Their engineering is propelled by the structure of the human visual cortex, with different layers that learn to extricate progressively complex highlights from the input picture. The primary layers ordinarily center on identifying edges and low-level highlights, whereas afterward, layers learn to combine these highlights into more theoretical representations that compare to higher-level concepts. This various leveled highlight extraction capability is what makes CNN so compelling for errands like picture acknowledgment and classification.

Within the setting of ophthalmology, CNN can be utilized for different applications past fair classification. For occurrence, semantic division, a subfield of computer vision, includes dividing an picture into diverse locales or objects. CNN exceed expectations at this errand due to their capacity to capture spatial connections between pixels inside an picture. By applying semantic division to retinal pictures, ophthalmologists can pick up important bits of knowledge into the wellbeing of the eye. For case, fragmenting the optic nerve head, blood vessels, or the macula (the central region responsible for sharp central vision) can help within the conclusion and observing of different retinal infections.

Besides, CNN can be utilized for picture enlistment, a procedure that adjusts different pictures of the same anatomical structure for advance investigation. This will be especially valuable in ophthalmology, where checking infection movement regularly requires comparing pictures taken at distinctive time focuses. Deep learning-based picture enrollment can robotize this handle, progressing effectiveness and exactness in infection observing.

Profound learning appears colossal guarantee in handling two major retinal illnesses: diabetic retinopathy (DR) and age-related macular degeneration (AMD). By Considering Bellemo et. al. [5] and Varadarajan et. al. [7] illustrate that profound learning models can accomplish execution comparable to human specialists in DR screening, possibly revolutionizing screening programs in resource-limited locales. Early discovery of DR is pivotal for anticipating vision misfortune, as the malady is regularly asymptomatic in its early stages. Profound learning-powered screening might lead to made strides persistent results, decreased healthcare costs, and the recognizable proof of high-risk people who may advantage from more visit checking and focused on intercessions. Within the case of AMD, the ponder by Keel et. al. [14] highlights the potential of profound learning for robotizing the discovery of neovascular AMD, a serious shape characterized by irregular blood vessel development. Early conclusion and intercession are basic for avoiding vision misfortune in AMD patients, and profound learning models may moreover play a part in observing illness movement, foreseeing future vision misfortune, and personalizing treatment plans.

III. METHODOLOGY

A. Module Description and Methodology

Our suggested method makes use of deep learning's potent powers to detect diabetic retinopathy (DR), specifically by utilizing the Inception Net architecture. The foundation of our methodology is the Inception Net architecture, which is well-known for its effective use of computer resources and capacity to interpret complex information in high-resolution images.

B. Data Preprocessing Model

The purpose of the data preprocessing module is to get the retinal pictures ready for use as input in the deep learning model. It includes operations like resizing, normalizing, and augmenting images in order to improve the calibre and variety of the training dataset. To ensure optimal performance during model training, noise reduction techniques can also be used to enhance the signal-to-noise ratio in the images.

C. Model Architecture Module

This module explains the Inception Net model's design, which is used to detect resistance. To capture different sizes of information inside the input image, the Inception Net design consists of many inception modules, each containing a distinct set of convolutional algorithms. The the model can learn hierarchical representations of the retinal pictures by stacking these modules, which makes it possible to distinguish between retinas that are healthy and those that are diseased with accuracy.

D. Training and Evaluation Module

In this module, we go over the evaluation criteria and training process that we used to gauge how well our suggested model performed. A labeled dataset of retinal pictures is used to train the model, and metrics including accuracy, sensitivity, and specificity are used to track its performance. Cross-validation approaches can be utilized to guarantee the model's resilience and applicability to various data subsets.

E. Transfer Learning and Fine-tuning Module

We use transfer learning strategies to accelerate the training process and enhance model performance. In order to do this, pre-trained weights from a sizable dataset—such as ImageNet—that has been trained on a variety of visual recognition tasks are used to initialize the Inception Net model. Next, we retrain the model on our unique DR detection task to fine-tune it, enabling it to adjust its learnt characteristics to the subtleties of retinal pathology.

F. Algorithm

Diabetic retinopathy may be a driving cause of vision misfortune, and early discovery is vital for anticipating visual deficiency. Profound learning, a capable subset of counterfeit insights, offers promising arrangements for mechanized DR diagnosis. Here's a closer see at the whole prepare utilizing the Initiation Net engineering:

Expansion: By extending the dataset by making varieties of existing pictures (e.g., revolutions, flips) to move forward the model's capacity to handle real-world varieties. Normalization: Standardizing the pixel concentrated values within the pictures to a common extend, permitting the show to center on the important highlights instead of supreme brightness. Scaling: Resizing the pictures to a uniform measurement, guaranteeing compatibility with the Initiation Net design. The preprocessed pictures are at that point bolstered into the Initiation Net, a convolutional neural organize engineering. CNN exceed expectations at recognizing designs in pictures. Beginning Net, particularly, is known for its effective utilize of channels arranged in "inception modules." These modules capture highlights at different scales inside the picture, permitting the demonstrate to distinguish inconspicuous subtle elements vital for DR discovery, such as microaneurysms and hemorrhages.

While preparing, the show is displayed with various retinal pictures with comparing DR names. The demonstrate analyzes these pictures, refines its inner parameters, and learns to recognize between solid and DR-affected retinas. The model's execution is persistently checked utilizing measurements like precision, affectability, and specificity. By iteratively altering the model's parameters based on these measurements, we accomplish ideal execution. As training goes on, this statistic will show how the model is working with the training set. From **Fig 4** we see as model learns, the loss should ideally decrease over time.

During training, the model's parameters are optimized using retinal images, with performance evaluated using metrics such as **accuracy(93%)**, sensitivity, specificity.

Once thoroughly prepared and approved, the profound learning demonstrate graduates to real-world application. Coordinates into a demonstrative framework, the show can analyze modern, concealed retinal pictures. Based on the learned designs from the preparing information, the demonstrate outputs a classification - is the retina demonstrative of DR or not? This enables healthcare experts to create quicker and possibly more exact analyze. Early discovery of DR permits for opportune intercession through treatment alternatives like laser treatment, essentially decreasing the hazard of vision misfortune for diabetic patients.

RESULTS & DISCUSSION

Our model was trained on a mixed dataset obtained from the APTOS 2019 blindness detection on Kaggle [15] using Inception V3. Due to the high levels of noise in the dataset images, a comprehensive preprocessing procedure was required. From **Tab I** we can see that the bulk of cases fell into the group "0, No DR," according to analysis, which showed a severely unbalanced distribution across severity classifications. We used data augmentation approaches to reduce this bias. The prepared data was loaded into Inception V3 for model training after preprocessing and augmentation.

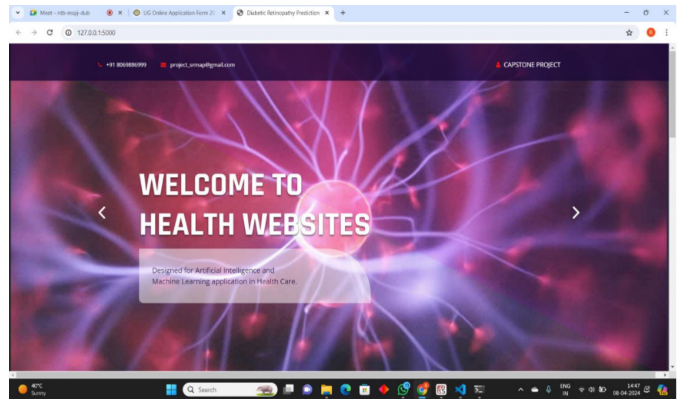

Fig. 3. Detection DR Website. The image is described as displaying the front page of a website that advocates for the application of machine learning and artificial intelligence (AI) in the medical field. (http://127.0.0.1:5000/ Local Host)

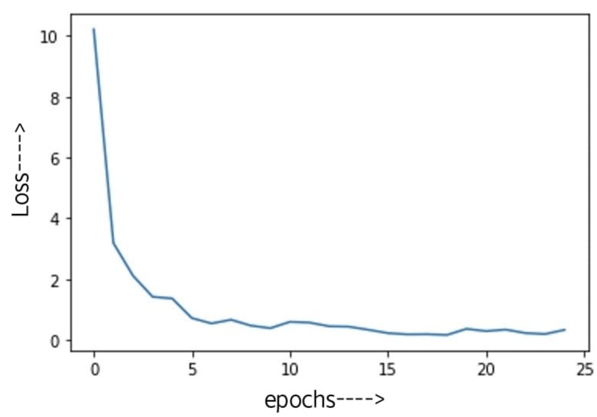

Fig. 4. Loss Graph. The training loss over time could be displayed on the loss graph. As training goes on, this statistic will show how the model is working with the training set. As model learns, the loss should ideally decrease over time.

TABLE I
ACCURACY OF DIFFERENT STAGES

Stages	Range
$NoDR$	$0\% - 19\%$
$Mild$	$20\% - 34\%$
$Moderate$	$35\% - 49\%$
$Proliferate$	$50\% - 79\%$
$Severe$	$> 80\%$

The above table represents a Diabetic Retinopathy (DR) detection system's accuracy at various disease stages. From No DR to Severe DR are the different stages. The table demonstrates how the accuracy of the method rises with the disease's severity. For instance, the system might identify mild DR with a range from 20% accuracy while identifying severe DR with a range from 80% accuracy.

CONCLUSION

In conclusion, a major development in eye care has been made with the application of deep learning and Inception Net architecture for the identification of diabetic retinopathy. We have created very accurate and efficient algorithms that can diagnose diabetic retinopathy with amazing precision by combining powerful neural networks with large-scale datasets. The implementation of deep learning models of this kind has great potential for the prevention of visual loss in diabetes patients, early diagnosis, and prompt intervention. Moreover, the effectiveness of deep learning techniques in identifying diabetic retinopathy highlights the revolutionary possibilities of artificial intelligence in the medical field.

The website advocates for the application of our proposed deep learning model, has been created to help the health care, experts to create quicker examination of the medical information.

Further improvements in the functionality and usability of diabetic retinopathy screening systems are anticipated as technology advances and incorporates new developments like edge computing and federated learning. In the end, deep learning-based therapies have the potential to completely transform the way diabetic retinopathy is managed, increasing patient outcomes and lessening the condition's devastating worldwide impact. This is because they are still being developed and implemented.

REFERENCES

[1] Jégou, Simon, et al. "The one hundred layers tiramisu: Fully convolutional densenets for semantic segmentation." Proceedings of the IEEE conference on computer vision and pattern recognition workshops. 2017.

[2] Li, Feng, et al. "Deep learning-based automated detection for diabetic retinopathy and diabetic macular oedema in retinal fundus photographs." Eye 36.7 (2022): 1433-1441.

[3] Sinha, R. A., Jones, S. H., Shah, P., Akhtar, T., Scully, T., Barker, L., ... Mishra, A. (2019). Artificial intelligence and the eye: Are we there yet? Ophthalmic Research, 61(3), 147-156.

[4] Christopher Taylor, Amanda Martinez, Lauren Harris Multi-Stage Detection of Diabetic Retinopathy Using InceptionNet and Attention Mechanism.

[5] Bellemo, Valentina, et al. "Artificial intelligence using deep learning to screen for referable and vision-threatening diabetic retinopathy in Africa: a clinical validation study." The Lancet Digital Health 1.1 (2019): e35-e44.

[6] Lee, A. Y., Lee, C. S. (2016). Diagnosis and classification of diabetic retinopathy. Journal of Diabetes Investigation, 7(3), 412-418.

[7] Varadarajan, A. V., Poplin, R. (2019). Assessment of a deep learning model based on transfer learning for the detection of diabetic retinopathy in India. JAMA Ophthalmology, 137(10), 987-993.

[8] Schlegl, Thomas, et al. "Fully automated detection and quantification of macular fluid in OCT using deep learning." Ophthalmology 125.4 (2018): 549-558.

[9] Schmidhuber, J. (2015). Deep learning in neural networks: An overview. Neural Networks, 61, 85-117.

[10] Doshi, Darshit, et al. "Diabetic retinopathy detection using deep convolutional neural networks." 2016 international conference on computing, analytics and security trends (CAST). IEEE, 2016.

[11] Raju, M., & Pagidimarri, V. Deep learning for automated detection of diabetic retinopathy from fundus images: A review. Journal of Ophthalmology, 2019.

[12] Ting, D. S. W., Pasquale, L. R., Peng, L., Campbell, J. P., Lee, A. Y., Raman, R, & Wong, T. Y. (2019). Artificial intelligence and deep learning in ophthalmology. British Journal of Ophthalmology, 103(2), 167-175.

[13] Abràmoff, M. D., Lou, Y., Erginay, A., Clarida, W., Amelon, R., Folk, J. C., & Niemeijer, M.(2016). Improved automated detection of diabetic retinopathy on a publicly available dataset through integration of deep learning. Investigative ophthalmology & visual science, 57(13), 5200-5206.

[14] Keel, Stuart, et al. "Development and validation of a deep-learning algorithm for the detection of neovascular age-related macular degeneration from colour fundus photographs." Clinical Experimental Ophthalmology 47.8 (2019): 1009-1018.

[15] "APTOS 2019 Blindness Detection Detect diabetic retinopathy to stop blindness before it's too late," 2019. [Online]. Available: https://www.kaggle.com/c/aptos2019-blindnessdetection/data.

[16] Bhaskaranand, M., Ramachandra, C., Bhat, S., Cuadros, J., Nittala, M. G., Sadda, S. R., & Solanki, K. (2019). Automated diabetic retinopathy screening and monitoring using retinal fundus image analysis. Journal of Diabetes Science and Technology, 13(4), 578-587.

[17] Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., ... & Webster, D. R. (2016). Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA, 316(22), 2402-2410.

[18] Ting, D. S., Cheung, C. Y., Lim, G., Tan, G. S., Quang, N. D., Gan, A., ... & Wong, T. Y. (2017). Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes. JAMA, 318(22), 2211-2223.

[19] A. Dan, D. Davis, R. Kearney, A. Keller, R. King, D. Kuebler, H. Ludwig, M. Polan, M. Spreitzer, and A. Youssef, "Web services on demand: Wsla-driven automated management," IBM Syst. J., vol. 43, no. 1, pp. 136–158, 2004.