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Survey on Diabetic Retinopathy Screening using Deep Learning

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Abstract: Diabetic retinopathy is a major disease that occurs in people with diabetes. Individuals with this condition may experience vision loss, which can be challenging to recover from. Deep learning algorithms have recently come into play as a viable method for DR screening automation. This study develops a deep learning powered method for detecting early diabetic retinopathy (DR) by training a convolutional neural network (CNN) on a large retinal picture into multiple DR severity levels. This system aims to achieve high accuracy, sensitivity, and specificity in identifying early signs of DR, enabling timely intervention and treatment. By streamlining the screening process, this deep learning approach holds great potential to improve the efficiency and accessibility of DR diagnosis, ultimately benefiting people with diabetes by preserving their vision and reducing the burden on healthcare systems.
Keywords:*CNN, Deep learning,DR Classification.*

1. INTRODUCTION:

Diabetic retinopathy (DR), a severe and progressive disease that impacts a diabetic patient's eye, can result in blurred vision and eventual blindness if not addressed and medicated early. Early detection is crucial for timely intervention and treatment. Deep learning approaches, particularly convolutional neural networks (CNNs), have transformed the examination of medical images and showcased significant potential in automating DR detection and classification. This study provides an in- depth review of the current state of practices in early DR detection using deep learning approaches. We will take a closer look at the major methodologies, and datasets, along with advancements in this field, as well as the challenges and potential futures. By synthesizing the existing literature, this survey offers valuable insights for researchers, healthcare professionals, and policymakers interested in leveraging the power of deep learning for DR screening, with the overarching aim of advancing patient care and safeguarding vision for people with diabetes.

Mudaser et al. (2021) [1] The proposed system method involves diabetic retinopathy categorization using a pretrained image processing model. Their approach likely consists of pre-processing strategies to improve the quality of images in advance of classification, which could lead to more accurate disease diagnosis and staging.

Chetoui et al. (2020) [2] explored the use of Efficient NET, an improved deep-learning strategy for diabetic retinopathy classifying with an emphasis on clearness. This implies that the authors made efforts to make the model's decisions interpretable, which is essential for medical applications.

Zhang (2020) [3] Investigated ssinto the application of deep learning to detect retinopathy's early symptoms. due to diabetes, specifically the Efficient NET architecture. The emphasis on early detection highlights the importance of timely intervention to prevent severe vision loss.

Sudarmadji et al. (2020) [4] proposed a new method for staging the disease in diabetics using advanced deep learning techniques. This "improved" approach is most likely referring to advancements in the deep learning model's architecture or training methodology, which could lead to more accurate and granular classification of retinopathy severity

2.LITERATURE SURVEY

Nijalingappa et al [5] (2015) Developed a machine learning-based strategy for detecting and staging diabetic retinopathy to accurately classify the disease, allowing for personalized treatment plans and improved treatments for patients.

Raja et al. (2019) [6] Using convolutional neural networks (CNNs), the proposed approach is designed as a machinelearning method for understanding blood vessels in retinal visuals. This step is essential for diabetic retinopathy detection, as it helps identify lesions and abnormalities, streamline the diagnostic process, and reduce human error.

Nazir et al. (2019) [7] Presented a novel approach to the diagnosis of diabetic retinopathy. Their method combined extreme machine learning techniques with tetragonal local octal patterns (TLOPs). TLOPs are fresh attributes that, when combined with ELMs' significant machine learning capabilities, can increase diabetic retinopathy diagnosis precision.

Gayathri et al. (2019) [8] proposed a classification framework for diabetic retinopathy that combines multipath convolutional neural networks (CNNs) and machine learning classifiers to improveaccuracy.
This approach aims to provide more reliable diagnostic results, which are essential for informed patient care.

Washburn et al. (2019) [9] investigated the use of the Adaboost classifier algorithm to evaluate the severity of diabetic retinopathy using this algorithm. Their research contributes to a better understanding of disease progression and helps determine the most appropriate treatment for each patient's condition.

Li et al. (2019) [10] A deep-learning algorithm was used to develop this system, which uses optical coherence tomography (OCT) images to diagnose diabetic retinopathy in its early stages. Their approach provides an advanced diagnostic tool for early intervention, which is essential for preventing vision loss in diabetic patients.

Islam et al. (2019) [11] presented an artificial neural network (ANNs) and pre-trained models approach based on deep learning,that can detect diabetic retinal damage in OCT images. This approach improved diagnostic accuracy, enabling more precise diagnosis and treatment planning.

Wahid et al. (2019) [12] Bidirectional long short-term memory (BiLSTM), support vector machines (SVM), and convolutional neural networks (CNNs) are integrated to develop an advanced algorithm for diabetic retinopathy identification in OCT images. By enhancing the breadth and accuracy of retinopathy classification, this combined strategy may enable more specialized therapeutic interventions.

Kazakh-British et al. (2019) [13] provided an automated method for classifying diabetic retinopathy and identifying blood vessels in retinal images using deep learning. This approach leverages convolutional neural networks to streamline the diagnostic workflow, enabling faster and more accurate patient assessment.

Anoop et al. (2019) [14] developed a deep learningbased method for DR classification using a CNN with fundus colour images. This approach is crucial for early DR diagnosis and classification, enabling timely intervention and disease management.

Nasir et al. (2019) [15] presented a deep learning technique for using a CNN to detect DR, proving how useful CNNs are for making accurate and timely diagnoses.

Chakrabarty et al.(2019) [16] Developed a deep learning method using cutting-edge machine learning techniques to identify DR to improve diagnostic accuracy and speed, making a significant contribution to the field.

Jiang et al. [17] (2017) Introduced a method for the automated screening of DR images DL approach by using a neural network like (CNN) implemented with the Caffe framework. This approach streamlines the screening process, improving efficiency and reliability.

Niranjana et al. (2023) [18] emphasized the importance of accurate Segmentation of retinal vessels to enable early detecting the eye damaging diseases, especially Diabetic retinopathy.

Rego et al. (2023) [19] Assessed the diagnostic for automated diabetic retinopathy screening system as deep learning approach and its analysis the ability of models to automate the diagnostic process.

Umapathy et al. (2023) [20] presented a DL based approach for Detecting DR Machine vision processing, textural feature extraction, and transfer learning, combining these techniques to enhance disease detection accuracy.

Kolla et al. (2023) [21] proposed a computationally efficient binary CNN-based approach to diabetic retinopathy classification, providing a streamlined efficient classification method.

Saranya et al. (2023) [23] proposed a DL based approach to detect DR using Dense Net models, offering a promising approach for accurate disease identification and staging.

3.THE EXISTING SYSTEM

There should be early diagnosis of diabetic retinopathy (DR) in order to treat it. Therefore, time constraints and inaccuracies hinder manual assessment while the sharing of patient data among institutions for automated diagnosis is limited because of privacy concerns. This paper introduces Diabetic Retinopathy Assessment (DRFL), a novel approach that leverages the strength of deep learning but still safeguards patient’s privacy. DRFL deploys a distributed learning framework in which deep learning models are trained together on various data from different institution thereby eliminating the need to share raw images. It also combines federated averaging and categorical entropy loss averaging in one hybrid loss function to combat both nonuniformity and redundancy in data collection. Another feature is extraction of multidimensional features from fundus images by central server that would otherwise be difficult to capture, as they reflect severity characteristics of DR, such as subtle lesions. This method handles several important challenges; for example, automation improves its accuracy and efficiency, locally stored information ensures data confidentiality and generalizability increases due to multiple databases involved. Some possible advantages include earlier detection leading to better outcomes for patients, reduced healthcare expenses, and wider availability of DR screening in resource-poor regions. Nevertheless, future research could consider more developed FL algorithms or model interpretation clinical decision support and integrating DRFL with clinical workflows for seamless adoption.

4.DATA COLLECTION AND PREPROCESSING

The first step in diabetic retinopathy classification using deep learning is to collect a dataset ofretinal images with labelled diabetic retinopathy labels. This can be done by collaborating with hospitals, clinics, or other organizations that have access to retinal images. Once the images have been collected, they need to be pre processed to normalize the data. This may involve the following steps:

Resizing the images: All the images in the dataset need to be resized to the same size. This is necessary because deep learning models require input images of a specific size.

Converting the images to grayscale: Deep learning models typically perform better on grayscale images than on colour images. Therefore, it is often recommended to convert the retinal images to grayscale before training the model.Other image processing operations, such as noise reduction, contrast enhancement, and histogram equalisation, can be performed on retinal images to improve their quality and facilitate the deep learning model's extraction of relevant features.

5.FEATURE EXTRACTION

It is used for identifying and extracting relevant information from fundus images to classify them as either having (DR) or not having DR is the process of feature extraction for DR classification. It is introducing as Deep Learning method for DR detection by using a neural network like CNN for feature extraction from images of the retina and FCN for classification.

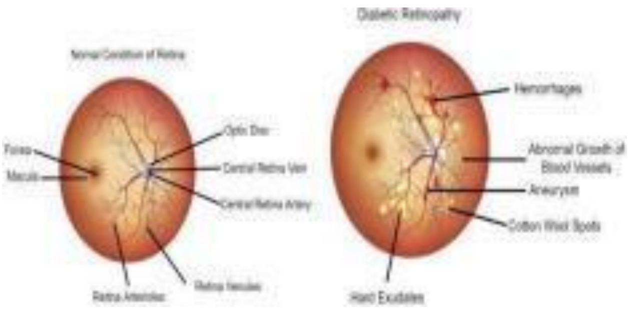

Fig.1 Feature Extraction

5.1.CNN CLASSIFICATION

5.1.1 Convolutional Layer (Convolution):

This layer is the initial layer of any neural network (CNN), is crucial for image recognition. It harnesses local receptive fields and shared weights to learn features from various regions of the input image. The image being processed is convolved using a variety of filters during convolution and each of which detects specific features and generates corresponding activation maps. These

activation maps represent key features of the input image. Based on the input and filter sizes, this layer computes its final result size. Neural activation functions introduce non-linearity to the layer.

5.1.2 POOLING LAYER (POOLING):

The pooling layer, a critical component of CNNs, prevents overfitting and reduces network parameters by performing non-linear down sampling. It divides activation maps into rectangles and selects the maximum values from each subregion, reducing the output layer size and managing computation and overfitting. The pooling layer significantly contributes to the network's robustness.

5.1.3 RELU LAYER (RECTIFIED LINEAR UNIT):

CNNs typically employ the ReLU utilized activation function sets zero for negative input values. introducing non-linearity and sparsity in hidden units. ReLU has proven to be an efficient activation function, enabling better training of deep neural networks than traditional sigmoid and logistic regression activation functions.

5.1.4 DROPOUT LAYER (DROPOUT):

This layer is a regularization method that makes a substantial contribution to the management of deep CNNs' excessive parameter proliferation. It mitigates overfitting by randomly deactivating some neurons in a layer before passing them to the next layer, particularly in fully connected layers. This contributes to the network's generalization and accuracy but can also result in some information loss between layers.

5.1.5 FULLY CONNECTED LAYER (FC LAYER):

It follows the convolutional and pooling layers and performs high-level reasoning for classification. It connects all neurons from the previous layers, forming a onedimensional layer.

5.1.6 CLASSIFICATION LAYER (SOFTMAX LAYER):

The final layer of a CNN, typically a softmax layer, performs image classification by assigning each input image to one or more classes.

6.CLASSIFICATION

The FCN is a classifier that takes the features extracted by the CNN and learns a mapping from the features to the two categories of diabetic retinopathy and non-diabetic retinopathy. Once trained, one of the two categories can be created from fresh retinal images using the FCN.

Diabetic retinopathy, a diabetes-related eye disease, damages the retinal blood vessels at the back of the eye. The following steps are used to identify the severity of the condition and guide treatment decisions:

Mild: Early-onset DR is marked and there are alterations in the blood vessels within the retina, that weaken and develop small abnormalities, such as microaneurysms (tiny outpouchings or swellings). Most people experience no noticeable vision problems at this stage, but regular monitoring and proper diabetes management are essential to prevent progression to more severe stages.

Moderate: In the moderate level of DR, the disease worsens, and the blood vessels undergo more significant changes. Haemorrhages (bleeding from blood vessels) and exudates (fluid and lipid deposits) become more pronounced, and vision may be affected. Individuals may notice blurred or distorted vision, especially in low-light conditions. Close monitoring and potential intervention, such as laser therapy, may be necessary at this stage to prevent further worsening of the condition.

SEVERE: Severe diabetic retinopathy is a late stage of the disease that poses a greater risk to vision. At this stage, the blood vessels are severely damaged and may become blocked or closed.

Proliferative diabetic retinopathy (PDR), a severe form of diabetic eye disease, is distinguished by the growth of fragile, atypical blood vessels on the retina. These vessels can cause bleeding and scarring, which can severely compromise vision. Symptoms of severe diabetic retinopathy include extensive vision loss, floaters, and even blindness if left untreated. Treatment, typically involving laser therapy or injections, is essential to prevent further damage and preserve vision.

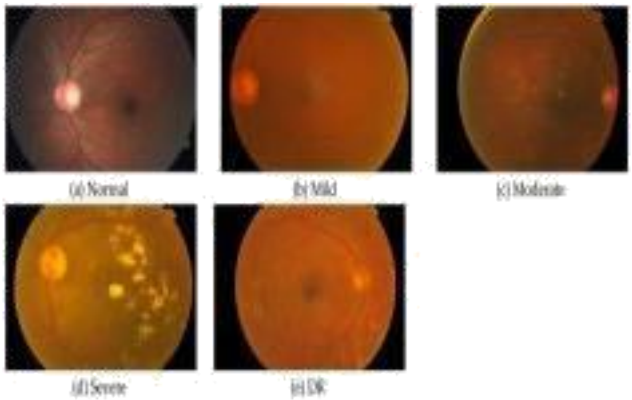

Fig.2 DR Classification

7.CONCLUSION

The study develops automated eye disease classification with promising benefits through image fusion, historical data and convolutional neural networks. The potential impact is on early detection of diseases, improving access to healthcare as well as preventing facial deformities it may cause. This paper lays down a basis for improvement in automatic eye disease detection by discussing methodologies such as data collection, pre processing, feature extraction and classification that are important in this field towards better patient outcomes and early intervention strategies.

8. INFERENCE FROM THE PAPER

This study introduces a new grading technique for DR severity using FL called DRFL. In DL,thereis a new innovative technology referred to as federated learning (FL) where the DL models are collectively trained without exposing clinical data. We applied FedAvg approach and median of categorical cross-entropy loss in this research work [10]. Median CE is more appropriate than FedAvg for ,both under-fitted and over-fitted clients [10]. Furthermore, we propose that the feature extraction should be done by novel central server using multi-scale features in order to detect micro aneurysms on fundus image.

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