Diabetic retinopathy prediction model using optimized VGH algorithm based deep CNN classifier- A Review

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Abstract: *Diabetic Retinopathy is one of the major causes found in Diabetic Patients. DR if not prevented may leads to eye blindness in a person. DR is basically a complication based on patients suffering from type-1 and type-2 diabetes. Diabetes now becomes a main challenge to our human health. Till now many technologies and algorithms have implemented to detect DR stage. To detect DR in early stages is must to prevent from blindness of an eye. In this paper we have discussed some of the different authors implemented the detection of diabetic retinopathy using different machine learning and deep learning algorithms. New technology can be implemented in future using the Vision guided horse optimizer (VGH algorithm), which is formed by the standard hybridization of the optics inspired and horse herd optimization that helps in achieving faster convergence.*

I. Introduction:

Diabetic Retinopathy turns out to be a major cause of blindness in the western world, and regular screening of the patients reduces the risk of blindness. Blood vessel damage in the retina is the main diabetic retinopathy pathophysiology, this may cause exudates, hemorrhages, and swelling of the retina.

Tiny blood vessels in the human retina were blocked due to increasing the blood sugar ratio. The earliest stage of diabetic retinopathy is referred to as background retinopathy. At this stage, diabetes does not affect the sight, but impairs the blood vessels. The vessels may slightly bulge (microaneurysms - MAs), leak fluid and proteins (exudates - EXs), and leak blood. Regular check-ups via diabetic retinopathy screening programs are essential for detecting the disease as early as possible and determining the adequate treatment.

Convolutional neural networks (CNN), and machine learning algorithms have also been implemented for automatic disease detection. Convolutional Neural Network

(CNN), a powerful deep learning architecture, has been applied in diverse vision-oriented areas ranging from natural image classification, human action recognition, to biomedicine, medical image segmentation, and diabetic retinopathy risk prognosis, to name a few. Convolutional networks have been consistently developed for object detection, classification, and segmentation. The use of convolutional neural networks (CNNs) on medical images has helped the medical sector immensely due to its ability to learn representations of data. CNNs can sense image features under various vision-related receptive fields, the approach can improve the classification of images when there are not enough high-quality labelled samples.

In recent decade many computer-aided systems have been developed for DR detection and diagnosis. Like CADe(Computer Aided detection systems) which work at the pixel level to detect, CADx(Computer aided diagnosis) which work at the image level to detect DR.

DR is divided widely into two levels: DR(PDR) Proliferative DR and DR(NPDR) non proliferative. PDR is analyzed by the growth of newly formed vessels, on the retina.

II. Literature Review:

Abhishek Samanta *et al.*[1] proposed the DR detection technique using Convolutional Neural Network. They proposed a transfer learning based CNN architecture on color fundus photography that performed very well on small dataset of skewed classes of 3050 training images and 419 validation images in recognizing classes of diabetic retinopathy from hard exudates, blood vessels and texture. The model was trained on Google collaborator. Transfer learning and fine-tuning on the pretrained DenseNet has proved to be extremely effective on this dataset and the training technique experimented by us paid off well in terms of achieving considerably good classification results. The model has no issues in detecting a healthy eye from a fundus photography. The F1 score of our model on a healthy eye is 0.97.

Wanghu Chen *et al.*[2] states an approach to retinal image classification is proposed based on the integration of multi-scale shallow CNNs. A learning system using our proposed approach is implemented with Python and the famous deep learning framework, TensorFlow, on Google platform with of Tesla P100. To verify the effectivity of our Performance Integration policy, we compared our proposed model two representative integrated shallow CNN models using Mean and Voting as policies

to integrate the classification results of their base learners respectively. proposed model use the policy called Performance Integration. It can be found that our proposed model can improve the accuracy from 2% to 9% compared with all these models. multi-scale shallow CNNs combined with performance integration is introduced to the early detection of Diabetic Retinopathy through the classification of retinal images. Owing to the feature sensing under various vision-related receptive fields by different base learners and the repeatable dataset sampling, it can do image classification well when there are not enough high-quality labelled samples. According to the experiments, the performance integration model shows advantage in accuracy compared with other integration models like that based on Mean and Voting. Moreover, the proposed approach also performs well on small datasets when considering of both classification effect and efficiency compared with other approaches.

LIFENG QIAO represents the detection of diabetic retinopathy using prognosis of Microaneurysm. In this paper the early diagnosis of diabetic retinopathy is implemented using deep learning algorithms. Microaneurysm is a minute aneurysm occurring on a vessel of small size, or such as occurs in thrombotic purpura. Microaneurysm dynamics primarily increase the risk that the laser photocoagulation requires progression to the level. MAs are the first signs of NPDR and are caused by focal thin blood vessel dilation, In this paper, Prognosis of Microaneurysm and early diagnostics system for non-proliferative diabetic retinopathy (PMNPDR) capable of effectively creating a deep-convolutional neural network for the semantic segmentation of fundus images which can improve NPDR detection efficiency and accuracy. The input images entered will be fed into convolutional layers for analysis A unit of a convolutional layer in an input image binds to a small area called the receptive field, always extends to the entire image range. The units are placed in the feature maps in a convolutional layer The unit on the same map of features is on the same filter bank If flattened and analyzed with a fully connected layer that contains several class neurons, then the output of the last normally dualmodule built to become a 336 dimensioned function vector in our job. Finally, the output of the fully associated layer is translated to the likelihood of every class by a Softmax function.

FAHMAN SAEED represents the Automatic DR Diagnosis using Adaptive fine-tuned CNN. In this paper, developed an intelligent computer-aided system using pre-

trained CNN for automatic DR and overfitting is unavoidable. It reduces the model complexity and avoiding the overfitting problem. It Proposed a two-stage fine-tuning method to adapt a pre-trained model to retinal fundus images. In first stage, it embeds the DR lesion structures in a pre-trained CNN model using lesion. In 2nd stage it adapts high-level layers to extract the discriminate structures of retinal fundus images by removing the domain specific fully connected layer(FC) and introduced new PCA layer which reduces the model complexity.

Cam-Hao Hua represents Convolutional Network with Twofold Feature Augmentation for DR Recognition from Multi-modal images. In this paper, proposed architecture comprises a backbone convolutional network associated with two fold feature augmentation mechanism TFA-Net. The proposed model achieves a Quadratic weighted Kappa Rate of 90.2%. TFA-Net Comprises a backbone network acquiring deep features through multiple blocks of convolutional layers. A Convolutional Network with Two-fold feature augmentation called TFA-Net is introduced for DR severity grading given a very small-scale dataset of fundus and wide field SS-OCTA modalities. The incorporation between data and feature level augmentation mechanism in the proposed network attains impressive recognition performance on the small-sized internal KHUMC and Messidor datasets.

HARSHIT KAUSHIK represents DR Diagnosis from fundus images using stacked Generalization of Deep Models. In this paper it is observed that the eye fundus images show various kinds of color aberrations and irrelevant illuminations, which degrade the diagnostic analysis and may hinder the results. They present a methodology to eliminate these unnecessary reflectance properties of images using a novel image processing schema and a stacked deep learning technique for the diagnosis. The proposed stack model reports on overall test accuracy of 97.92%(binary classification) and 87.45 (multi-class Classification). It used a dataset that has multi-sourced images. Therefore various types of noise and distortions are encountered in the images. After the data acquisition, the image luminosity is normalized by the color constancy based gray world algorithm. The data is split into training and test sets for the stacking convolutional model. Three different sub models of CNNs are fed into a single meta-learner classifier for feature extraction. Meta-learner classifier produces the diagnostic result as healthy (NO DR) or unhealthy (DR).

MOHAMED M. ABDELSALAM represents A Novel Approach of DR Early detection based on multifractal Geometry analysis for OCTA Macular Images using SVM. Here analyzing the mascular optical Coherence tomography angiography (OCTA) images for diagnosing early non-proliferative DR (NPDR). The classification technique had achieved 98.5% accuracy. Using fundus images different regions of interest were clustered by using k-means color compression technique, with segmenting out the diabetic parts, finally uses fuzzy inference system (FIS) as a classification.

III. Convolutional Neural Network (CNN)

Convolutional neural networks (CNN), and machine learning algorithms have also been implemented for automatic disease detection [16][17][18][6]. Convolutional Neural Network (CNN), a powerful deep learning architecture, has been applied in diverse vision-oriented areas ranging from natural image classification [19] [20], human action recognition [21], [22] to biomedicine [23], medical image segmentation [24], and diabetic retinopathy risk prognosis [25], to name a few [5]. Convolutional networks have been consistently developed for object detection, classification, and segmentation. The use of convolutional neural networks (CNNs) on medical images has helped the medical sector immensely due to its ability to learn representations of data [26] [1]. CNNs can sense image features under various vision-related receptive fields, the approach can improve the classification of images when there are not enough high-quality labelled samples [2]. CNNs have been used for the classification of Diabetic Retinopathy [27, 28], given a big dataset and considerable computing power [29]. They have been instrumental in detecting the features such as haemorrhage and hard exudes that identify retinopathy [1]. Large CNNs can successfully perform highly complex image recognition tasks with an outstanding norm for many object classes. In many typical image-classification projects, CNNs, like the annual ImageNet, are used [30], [31] [3].

IV. Research Methodology

The main aim of the research is to identify diabetic retinopathy by using a deep CNN classifier. The input for the research is collected from the Indian Diabetic Retinopathy Image Dataset (IDRID) as retinal fundus images. The collected input image is fed forwarded to preprocessing stage in order to enhance the quality of the image, which is

performed in a twofold process such as image contrast enhancement and illumination correction. In image contrast enhancement, the enhancement of images is performed by enhancing the RGB color bands, since the colour of the image is formed by these bands. Improving the contrast of RGB bands helps in improving the perception of the image. The goal of illumination correction is to remove uneven illumination of the image caused by non-uniform illumination and in this research pixel level illumination correction is used. The luminosity enhanced image obtained as the output of the preprocessing stage is segmented based on the blood vessels and optical disc, which plays a major role in causing diabetic retinopathy.

Two different approaches are used for this segmentation, such as Ostu thresholding method and contour based segmentation method. The Otsu thresholding method is used for the segmentation of optical disc by iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold. The contour based thresholding approach is used for the segmentation of blood vessels. The significant contribution of the research relies on the Vision guided horse optimizer (VGH algorithm), which is formed by the standard hybridization of the optics inspired [34] and horse herd optimization [33] that helps in achieving faster convergence. The schematic representation of the methodology is shown in figure 1.

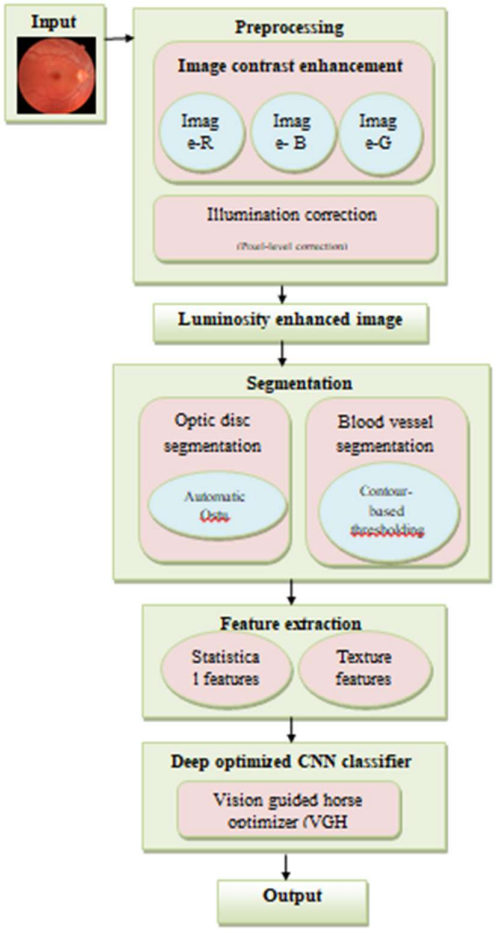

Figure 1:

V. Conclusion and Future Work

In this paper various technologies developed for detection of diabetic retinopathy is discussed. Using the deep Classifier the detection time will improve and the vision loss can be

saved. The improvement will be achieved due to the enabling of the VGH algorithm. This will boost the convergence of the classifier and helps in obtaining efficient output. The training time will be decreased using the optimization algorithm and the effective feature extraction will helps in reducing the dimensionality to a greater extent. This is the reason behind the improvement.

References:

[1] Samanta, Abhishek, Aheli Saha, Suresh Chandra Satapathy, Steven Lawrence Fernandes, and Yu-Dong Zhang, "Automated detection of diabetic retinopathy using convolutional neural networks on a small dataset," Pattern Recognition Letters, vol. 135, pp. 293-298, 2020.

[2] Chen, Wanghu, Bo Yang, Jing Li, and Jianwu Wang, "An approach to detecting diabetic retinopathy based on integrated shallow convolutional neural networks," IEEE Access, vol. 8 pp. 178552-178562, 2020.

[3] Qiao, Lifeng, Ying Zhu, and Hui Zhou, "Diabetic retinopathy detection using prognosis of microaneurysm and early diagnosis system for non-proliferative diabetic retinopathy based on deep learning algorithms," IEEE Access, vol. 8, pp. 104292-104302, 2020.

[4] Saeed, Fahman, Muhammad Hussain, and Hatim A. Aboalsamh, "Automatic diabetic retinopathy diagnosis using adaptive fine-tuned convolutional neural network," IEEE Access, vol. 9, pp. 41344-41359, 2021.

[5] Hua, Cam-Hao, Kiyoung Kim, Thien Huynh-The, Jong In You, Seung-Young Yu, Thuong Le-Tien, Sung-Ho Bae, and Sungyoung Lee, "Convolutional network with twofold feature augmentation for diabetic retinopathy recognition from multi-modal images," IEEE Journal of Biomedical and Health Informatics, vol. 25, no. 7, pp. 2686-2697,2020.

[6] Kaushik, Harshit, Dilbag Singh, Manjit Kaur, Hammam Alshazly, Atef Zaguia, and Habib Hamam, "Diabetic retinopathy diagnosis from fundus images using stacked generalization of deep models," IEEE Access, vol. 9, pp. 108276-108292, 2021.

[7] Abdelsalam, Mohamed M., and M. A. Zahran, "A novel approach of diabetic retinopathy early detection based on multifractal geometry analysis for OCTA macular images using support vector machine," IEEE Access, vol. 9, pp. 22844-22858, 2021.

[8] Araújo, Teresa, Guilherme Aresta, Luís Mendonça, Susana Penas, Carolina Maia, Ângela Carneiro, Ana Maria Mendonça, and Aurélio Campilho, "Data augmentation for improving proliferative diabetic retinopathy detection in eye fundus images," IEEE Access, vol. 8, pp. 182462-182474, 2020.

[9] Liu, Tieyuan, Yi Chen, Hongjie Shen, Rupeng Zhou, Meng Zhang, Tonglai Liu, and Jin Liu, "A Novel Diabetic Retinopathy Detection Approach Based on Deep Symmetric Convolutional Neural Network," IEEE Access, vol. 9, pp. 160552-160558, 2021.

[10] G. García, J. Gallardo, A. Mauricio, J. López, and C. Del Carpio, ‘‘Detection of diabetic retinopathy based on a convolutional neural network using retinal fundus images,’’ in Proc. Int. Conf. Artif. Neural Netw. Cham, Switzerland: Springer, pp. 635–642, 2017.

[11] R. Donnelly, ‘‘ABC of arterial and venous disease: Vascular complications of diabetes,’’ BMJ, vol. 320, no. 7241, pp. 1062–1066, 2000.

[12] International Diabetes Federation, vol. 10, pp. 353–356, 2018. [Online]. Available: https://diabet. esatlas.org/

[13] A. V. Chappelow, K. Tan, P. K. Kaiser, and N. K. Waheed, ‘‘Reply,’’ Amer. J. Ophthalmol., vol. 153, no. 4, p. 781, 2012.