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Diagnosis Of Diabetic Retinopathy: A Survey

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Abstract: Diabetic Retinopathy (DR) which is an eye-related disease that usually occurs in diabetic patients due to an increase in blood sugar content level. As the diabetes progresses in different stages, the patient's eyesight may or may not weaken, which is the sign of the early stage of DR. On increasing blood sugar levels in these patients, DR is a major concern of the world's population as the advanced stage may cause complete vision loss. The early detection is necessary for the treatment, but the diagnosis of DR is difficult and expensive for a common man to afford as the task demands highly qualified doctors to check the existence of different features present at different stages of DR, which leads to time consumption and delay in reports. In this paper we have done a survey on the different techniques used for detection diabetic retinopathy.

Keywords: Diabetic Retinopathy (DR); Deep learning; Convolutional Neural Network (CNN); Fundus Images

I. INTRODUCTION

One of the major reasons for visual impairment in the developed world's working-age population is the diabetic retinopathy. About 93million people are estimated to be affected by Diabetic retinopathy. It's a condition that causes harm to the retina. It is also called diabetic eye disease. It is found in people with diabetes. It is also a progressive disease, which does not have any early symptoms. Until it influences the vision it frequently goes unnoticed. It is the main reason for vision loss in people with diabetics and a significant cause for blindness in working aged adults. When Diabetic Retinopathy (D.R) is identified in time, progress of vision impairment may be delayed or prevented, however this is challenging as the condition sometimes displays no signs until it seems to be past the point of no return, so it is tough to give viable treatment.

The World Health Organization states that about 347 million people are there in this world, living with diabetes. D.R is an eye disease due to long-term diabetes. About 40 to 46 percent of people who have diabetic conditions have the stage of D.R. Until it affects the vision DR often goes unnoticed due to the lack of early symptoms. Vision lost due to DR is almost irreversible. However early diagnosis and timely treatments will cut back its risk. The diagnosis of DR takes a lot of time and manual procedure involving a qualified clinician to review and analyze the retina's digital color fundus images. Human readers may submit their reviews, often a day or two later, that can delay the results which leads to lost timely follow up, improper communication, and delayed treatment. The presence of lesions due to vascular abnormalities are used to identify DR by clinicians. Although this approach is effective, there are high resource requirements. Skilled doctors and equipment needed are often missing at places where the rate of diabetics in the local population is very high and detection of DR is most needed. As the variety of human beings with diabetes keeps increasing, the services needed to prevent DR blindness will become more insufficient.

II. LITERATURE SURVEY

Much work has been done by researchers in the field of Diabetic Retinopathy, depending on their research area and field of interest. The related work in the field of medical sciences as well as machine learning, shows that researchers have proposed and implemented various machine learning methods, but the comparative study among these deep learning methods is still lacking for as far as Diabetic Retinopathy is concerned. The work done hence proves to be a novel approach while considering the results and finding various machine learning algorithms for DR.

A deep convolutional neural network (CNN) pixel-wise exudate detection was proposed by Shuang Yu, Di

Xiao and Yogesan Kanagasingam [1]. For the image processing procedure, the retinal images are first processed to remove the optic disc and blood vessels. Local phase symmetry algorithm is adopted for detection of optic discs. Exudate candidate points are obtained with the ultimate opening algorithm. The database used in this research is E-Ophtha EX. It had a total 82 images, including 47 exudate images and 35 normal images. In order to keep the balance of two classes, the number of negative samples is selected comparable to that of positive samples. The network has been trained for 150 epochs. A pixel-wise accuracy of 91.92%, sensitivity of 88.85% and specificity of 96% is achieved with the proposed CNN architecture on the test database. The dataset used contained only 82 images. In this paper convolutional neural networks are used to identify exudates in pixel level. It does not show whether the retinal image has diabetic retinopathy or not.

Suriyal, S. Druzgalski C. and Gautam [2] proposed a system that uses TensorFlow, Deep Neural Networks for classification and MobileNets with 28 Convolutional Layers. The Dataset consisted of ~17K Images. The application makes use of the robust deep neural network architecture MobileNets that is trained on millions of ImageNet images. The accuracy of the model comes out to be about 73.3% and the sensitivity of the model is 74.5 % while specificity is 63%. A major drawback of this paper has a huge graph file of neural networks due to which there are a large number of calculations as it contains many numbers of nodes. The accuracy can be further increased by applying more preprocessing techniques to the image datasets like thresholding, histogram equalization and data augmentation.

Qomariah, D. U. N., Tjandrasa, H., and Fatichah, C. [3] proposed a paper in which automated tools are suggested to detect diabetes using DR images using CNN. This paper implements a customized (5 layers, 2 convolution layers to extract features and 3 fully connected neural networks for classification) CNN model proposed only for the specific problem of classification of DR images. SVM gave the highest accuracy of 95.83% and VGGNet type 19 gave the accuracy of 95.24%. The future work for this paper is to include the training process that can be expanded for a bigger amount of data and classes as the major drawback of it is the Messidor Dataset, a small dataset of 1200 images which can be very less if a higher accuracy needs to be achieved.

Multiple eye disease detection using Deep Neural Network proposed by Prasad, K., Sajith, P. S., Neema, M., Madhu, L., and Priya, P. N. [4] incorporated a user-friendly and user interpretable form of GUI. It Detects the presence of diabetic retinopathy and glaucoma at its early stages. The system was tested by inputting both the test set images as well as the images taken live for both the diseases Diabetic Retinopathy and Glaucoma respectively. The detection of eye disease was carried out in 2 phases. Phase 1 included the training phase and the testing phase, and Phase 2, the development of GUI for real-time detection. The datasets used were Kaggle and Medimrg. Real-time detection of eyes was done by acquiring the image through a fundus camera and testing it on the pre-trained model. The predicted result gives a percentage of 72.45, 58.32 and 59.97 respectively which confirms the actual result and was displayed through the webpage. Accuracy could be further improved by performing parameter tuning and adopting methods like cross-validation.

Doshi, N., Oza, U., and Kumar, P [5] proposed a novel approach to deal with large and varying size input data by downscaling methods and multichannel CNN. Kaggle and Indian Diabetic Retinopathy Image Dataset were used. First, preprocessing of various images was done by cropping, downscaling and padding and transformed all images to a fixed size i.e 600x600x3. The image was downscaled by 8x times as downscaling by 16x and 32x times led to a greater loss of information and features of the image were not retained. Then the classification on the preprocessed images was performed using the Inception V3 network. Large image sizes are the major issues while dealing with biomedical image classification problems. Downscaling of images thus becomes an important part of preprocessing. The model was able to classify the fundus images and report using metric - 85.2% accuracy, 83.4% sensitivity and 87.6% specificity. Higher value of specificity is not obtained as the network learned on a highly skewed dataset. So, by changing the type of dataset used, a high level of specificity can be achieved.

Jayakumari, C., Lavanya, V., and Sumesh, E. P. [6] implemented an ImageNet model which achieved an impressive performance in DR detection and N method to detect and classify DR into four classifications like normal, mild, severe and proliferative. . They used Histogram equalization (HE) algorithm to reduce image noise, improve image contrast, and enhance image brightness. To detect and classify images of the retina ImageNet CNN was used and this research makes use of the Kaggle dataset for training and tests. And the CNN model is built in Python with the TensorFlow framework. Python libraries are used for preprocessing and matplotlib and for graph plotting. Sequential model is used that helps to build the model layer by layer the model has achieved an 86.6% accuracy of No DR, mild with 62.5%, moderate with 66.6%, severe with 57.1% and PDR with 42.8%. Testing also achieved good results with some misclassification due to the unavailability of more images in all categories. So, the model might obtain more accuracy if the number of images is increased in all the categories. Inception V3 Convolution neural networks can be mainly applied to excavate the deep information of a multi-layer network in the process of DR detection and classification.

Lands, A., Kottarathil, A. J., Biju, A., Jacob, E. M., and Thomas, S [7] proposed a model which was able to classify fundus images on the basis of diabetic retinopathy in 0-4 stage at an accuracy of 78 percentage. APTOS 2019 Kaggle Competition contained 3,662 image samples and APTOS 2015 Kaggle Competition contained

19640 image samples. A Total of 23302 image samples were used. Data Augmentation was done by Flipping, Brightness, Contrasting of dataset. Gaussian Blur Subtraction and data augmentation were done as a part of image preprocessing. The architectures used for training the model are ResNet50, DenseNet121, DenseNet169, Densenet256. DenseNet architecture had a normalization layer then 1 cross 1 convolution layer and 2 cross 2 average pooling layer. ResNet architecture with 50 layers was used. They trained the model with 10 epochs. After testing and retraining, the model was used to develop the system that has user friendly interference. For future enhancement, a neural network model was suggested.

Fang, T [8] proposed A Novel Computer-Aided Lung Cancer Detection Method Based on Transfer Learning from GoogLeNet and Median Intensity Projections has remote access to the GPU-based system was enabled through a web server; this allowed long-distance management of the detection system and its transition into a practical tool. In the future, testing data can also be collected through this channel for adjustment of the system. The trained system produced 81% accuracy, 84% sensitivity, and 78% specificity after 300 epochs, better than other available programs and the main issue is Network depth and inception modules are more complex. So, by implementing The net effects of the system's two core factors - fine-tuned GoogLeNet and MIPs - were revealed via a controlled variable experiment; this opened up space for future studies of these two factors, which have the potential of achieving even higher accuracy in lung cancer detection.

Sadhukhan, S., Ghorai, G. K., Maiti, S., Sarkar, G., and Dhara, A. K. [9] proposed deep learning framework shows satisfactory robustness on normal and diabetic retinopathy fundus images. The method achieves 98.75% accuracy of optic disc localization on the Messidor database. The less value of Euclidean distance is an indication of perfectness of localization of optic disc. The average Euclidean distance is 14 pixels for the proposed method. The proposed method has achieved an average 0.15 millisecond OD segmentation time per image, but a failure case was found due to poor contrast between OD and background. Implementing the proposed system using the method called Mask R-CNN, extends Faster R-CNN. Mask R-CNN is simple to train and adds only a small overhead to Faster R-CNN.

Aishwarya Singh Gautam, Saikat Kumar Jana, Manash Pratim Dutta [10] proposed a MATLAB based image processing and Biomedical Engineering is used to identify whitish lesions, cotton wool spots and hard exudates associated with DR. Fundus optical images are obtained from fundus photography. Preprocessing is done by resizing the colored image and then it is transformed to grayscale image. This image is then processed for contrast equalization which brightens the area which has to be identified. Then histogram equalization is performed to enhance the contrast. After that image processing technique thresholding is done. After Thresholding, the areas which are bright are segmented out and remain white. Other areas turn black. Using this method, the pixel count of DR and NDR are collected and compared with the dataset which was already classified. After analyzing, the pixel count of DR images was high whereas the pixel count of NDR was significantly low. In this paper fundus images are obtained from fundus photography which requires a fundus camera. This method can classify whether the input image is DR or NDR.

III. EXISTING SYSTEM

Diagnosis of DR traditionally involves a doctor or a clinician and demands few tests to be assured that the patient is suffering from Diabetic Retinopathy or not. Some of those tests are fluorescein angiography test, dilated eye exam and optical coherence tomography (OCT) exam. These tests are time consuming and too costly to be performed and need expert supervision. There are already several algorithms for the automatic detection of diabetic retinopathy using Support Vector Machine, Digital Image Processing etc. But these techniques only show whether the eye has DR or not and the accuracy of these techniques is questionable and is moreover complex in nature.

IV. CONCLUSION

Table 1 shows the comparative study of different methods/architectures to detect diabetic retinopathy.

	Diagnosis	**Dataset**	**Classification Algorithm / Architecture**	**Processing Parameters**	**Image Processing Algorithm**	**Final Result / Accuracy**
Paper [1]	Pixel-wise exudate detection.	E-Ophtha EX (82 images)	CNN	Potential exudate Candidates (seed points)	Local phase symmetry algorithm for optic disc detection and opening algorithm to obtain exudate candidates	91.92%
Paper [2]	Diabetic Retinopathy Detection using Deep Neural Network	Kaggle Dataset consisted of ~17K Images	TensorFlow, MobileNets	Weights, biases and uses graphs for preprocessing	_	73.3%

Paper [3]	Diabetic Retinopathy and Normal Retinal Images using CNN and SVM	Messidor Dataset containing 1200 images	CNN, SVM	Microaneurysms, Hemorrhages, Exudates, and Blood vessels	Combination of resnet50 and SVM	SVM gave accuracy of 95.83% and VGGNet gave the accuracy of 95.24%.
Paper [4]	Detection of Diabetic Retinopathy and Glaucoma	Kaggle, Medimrg	CNN	Microaneurysms	_	80%
Paper [5]	No DR, Mild, Moderate, Severe, Proliferative DR	Kaggle (35216 images), Indian Diabetic Retinopathy Image Dataset (516 images)	Multi-Channel Inception V3	Retinal tissues wells	Learned ImageDown sampling	Accuracy of 85.2%, Sensitivity of 83.4% and Specificity of 95%
Paper [6]	Normal, Mild, Moderate, severe NPDR	Kaggle Dataset	DL Algorithms	Retinal fundus images	Histogram equalization (HE) algorithm	Training accuracy of 98.8% and Validation accuracy of 98.5%
Paper [7]	No DR, Mild, Moderate, Severe, Proliferative DR	APTOS 2019 Kaggle ompetition (3,662 images) and APTOS 2015 Kaggle Competition (19640 images)	ResNet50, DenseNet121, DenseNet169, Densenet256	Funds images	Gaussian Blur Subtraction and data augmentation	78%
Paper [8]	Lung Cancer	LIDC-IDRI (1018 scans)	CNN structure similar to GoogLeNet	Benign and Malignant nodules of lung	Median Intensity Projection	81%
Paper [9]	Localization in Retinal Fundus	MESSIDOR-II dataset	Faster R-CNN	Optic Disc, Retinal Vasculature and Macula	_	98.75%
Paper [10]	DR and NDR	Fundus photography	Biomedical Image Processing (BIM)	Whitish lesions, cotton wool spots and hard exudates	Histogram equalization and thresholding.	The value of white pixel counts is larger in DR than that of the NDR pixel counts

Table 1. Comparison Table

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