Detection of Diabetic Retinopathy using Convolutional Neural Network

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Abstract – *Diabetic Retinopathy is a micro vascular disorder that occurs due to the effect of diabetes that causes vision damage to the retina, eventually leads to blindness. Early detection of diabetic retinopathy protects the patients from losing their vision. Detecting diabetic retinopathy manually consumes lot of time and patients have to undergo series of medical examinations. Hence, an automated system helps in an easy and quick detection of diabetic retinopathy. The proposed system inputs the image, extracts the features such as micro aneurysms, exudates and haemorrhages and classifies input image using convolution neural network as normal or diseased based on its severity level. The result obtained from the proposed method gives an accuracy value of 83%. And the system also predicts the severity level as mild, moderate, proliferate and severe.*

Key Words: Diabetic Retinopathy (DR), Convolutional Neural Network(CNN).

1. INTRODUCTION

There are approximately ninety three million people suffering with diabetic retinopathy worldwide. This number seems to increase exponentially day by day. DR involves different degrees of micro aneurysms, hemorrhages and hard exudates in the peripheral retina. There exists various effective treatments that would reduce the development of the disease provided it is diagnosed in the initial stages itself. The development of DR is a gradual process. There are various symptoms of DR such as fluctuating and blurred vision, dark spots and sudden vision loss. A web application is implemented in this paper which automatically detects DR when an image is uploaded and is capable of classifying the images based on the severity levels.

1.1 Literature Survey

Abnormality Detection in retinal images using Haar wavelet and First order features [1]. A machine learning technique has been a reliable one. The method classifies abnormality detection in retinal images using Haar wavelet and First order features. Diaretdb0 and Diaretdb1 are used as the databases. A comparative study of Decision tree classifier and a KNN classifier is performed. Encouraging results were found with the classification accuracy of 85% with K-Nearest Neighbor classifier and 75% accuracy with decision tree classifier. An automated detection of DR is done on real time basis. The system proposed in this paper is computationally inexpensive. The retinal image is classified as healthy or diseased based on the application of haar wavelet and first order histogram features.

Image processing technique are proposed here which introduces a computer assisted diagnosis based on the digital processing of retinal images.[2] in order to help people detecting diabetic retinopathy in advance. The main goal is to automatically classify the grade of non-proliferative diabetic retinopathy at any retinal image. For that, an initial image processing stage isolates blood vessels, micro aneurysms and hard exudates in order to extract features that can be used by a support vector machine to figure out the retinopathy grade of each retinal image. Several image pre-processing techniques have also been proposed in order to detect diabetic retinopathy. However, despite all these previous works, automated detection of diabetic retinopathy still remains a field for improvement. Thus, this paper proposes a new computer assisted diagnosis based on the digital processing of retinal images in order to help people detecting diabetic retinopathy in advance.

An automated computer aided system is proposed in [3] for the detection of DR using machine learning hybrid models by extracting the features like micro aneurysms, hemorrhages and hard exudates. The classifier used in this proposed model is the hybrid combination of SVM and KNN. Early medical diagnosis of DR and its medical cure is essential to prevent the severe side effects of DR. Manual detection of DR by ophthalmologist takes lot of time and the patients need to suffer lot. Hence, a system like this which is automated can help in detection of DR quickly and we can easily follow up treatment to avoid further effect to the eye.

A robust automated system [3] is proposed which detects and classifies the different stages of DR. The raw fundus images are processed for removing noise and converting these images into gray images using the steps for preprocessing to ensure easier post processing. The optic disc and retinal nerves are segmented. The features extracted are taken as input parameters for the classification model for classifying the images. The retinal nerves and optic disc are segmented, and using Gray Level Co-occurrence Matrix (GLCM) method the features are being extracted. An UI is implemented that contains a push button to load an image which is used to upload the input image then by using the radio button present in the classifier is to be chosen by the user for the classification process. After the classifier is chosen the processing button is pressed which will process and show all the processed images with the result of the classification as the stage of the Diabetic Retinopathy predicted.

An Interpretable Ensemble Deep Learning Model for Diabetic Retinopathy Disease Classification [5] is proposed to detect the presence of DR using multiple well – trained deep learning models. The models makes use of various deep learning model that are integrated with the help of Adaboost algorithm. The weighted class activation maps (CAMs) are used to demonstrate suspected position of lesions. There are eight transformation ways introduced that helps in data augmentation. The integrated model shows prominent results when compared to the other individual deep leaning models

1.2 Proposed System

In this paper a web application is introduced for the detection of DR where the user has to first register using valid credentials. The user then uploads the images on the successful completion of registration. The process of prediction is carried out by the model based on the input image provided by the user. The model highlights the usage of an eighteen layers deep ResNet-18, a CNN model. CNN diagnoses from digital fundus images and accurately classifies the severity of DR. CNN architecture and data augmentation help to identify features involved in the classification. The raw data is pre-processed to make it suitable for machine learning model. The selected images undergo segmentation on parameters such as presence of blood vessels, Micro aneurysms, Hemorrhages and exudates. After the segmentation process the feature extraction process takes place. The feature extraction step results in the classification of normal and abnormal image. The normal classifier indicates the absence of diabetic retinopathy. The Abnormal classifier indicates the presence of diabetic retinopathy and predicts the severity rate as mild, moderate, proliferate or severe. The resultant prediction is shown in the web page.

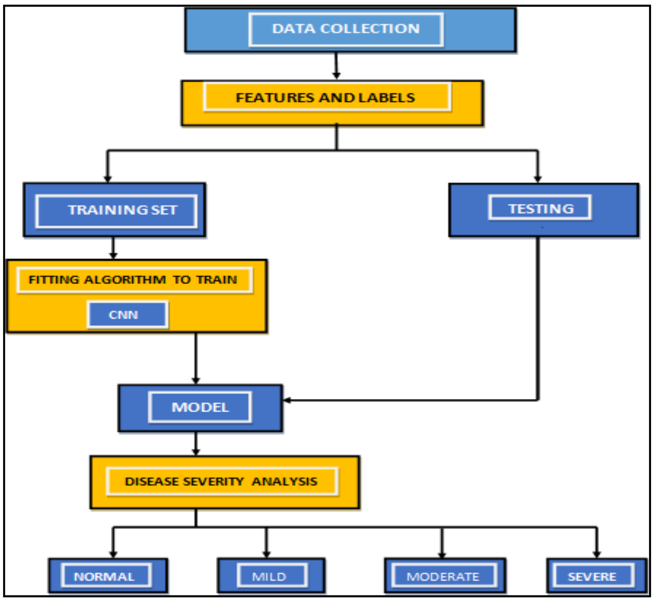
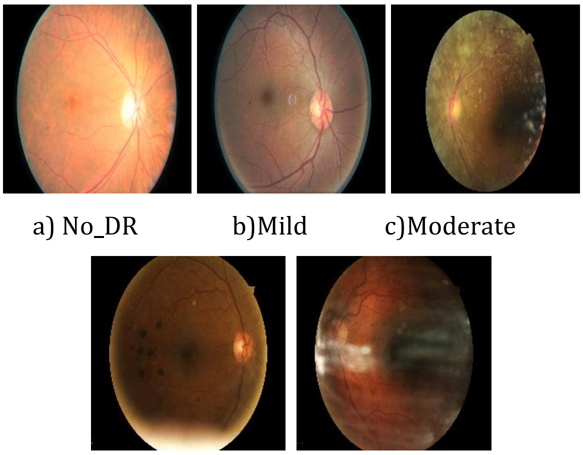


Fig 1: Architectural Flow

2. IMPLEMENTATION

2.1 Dataset

The primary data source for the proposed system is collected from kaggle. The dataset contains 8596 images. The images in the dataset are further classified into 5 categories out of which, 3650 are normal 1392 are mild, 1972 are moderate, 708 are proliferate and 874 are severe respectively.



a) No_DR b)Mild c)Moderate

d)Proliferate e)Severe

Fig 2: Image Dataset

2.2 Data Augmentation

The data frames consists of training and testing sets of data. Scikit-Learn is used to spilt the dataset out of which twenty percent is spilt to testing and eighty percent is spilt to training. Further two data generators are created each of which is used for training and testing respectively. The original images from the dataset are rotated and rescaled. The training set is further divided into three namely train, test and validation. Validation is used throughout the training process. The process of rescaled of the images is carried out in the testing set, where the images are rescaled to 256 X 256 pixels and split into thirty two batches each.

2.3 Convolutional Neural Network

CNN takes the images from the training dataset consisting of 5 different classes namely normal, mild, moderate, proliferate and sever. CNN consists of a dense fully connected neural network having input, hidden and output layer. All the neurons in CNN are fully connected. The input image is fed in CNN where feature extraction is carried out. The pooling layer compresses the feature map. These feature maps are flattened and fed to the dense fully connected layer before the classification. In general each of the CNN layer learns filters in the increasing order of their complexity. The first layer learns the basic feature extraction. The middle layer learns about the detection of the objects and the final layer learns to detect the object.

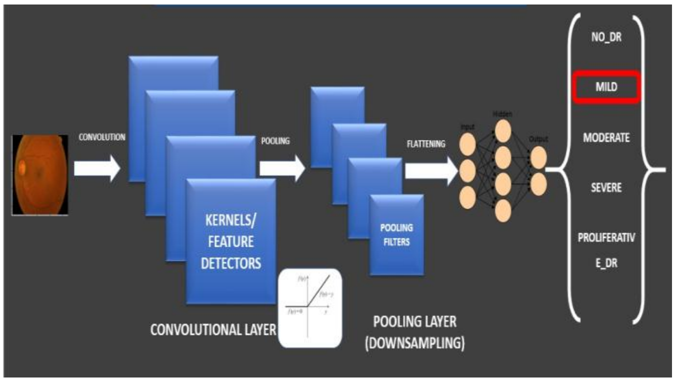


Fig 3. CNN Architecture

2.4 Residual Network

As CNNs grow deeper, vanishing gradient tend to occur which negatively impact network performance. Vanishing gradient problem occurs when the gradient is back-propagated to earlier layers which results in a very small gradient. Residual Neural Network includes "skip connection" feature which enables training of 152 layers without vanishing gradient issues. Resnet works by adding "identity mappings" on top of the CNN.. ImageNet contains 11 million images and 11,000 categories. ImageNet is used to train Res Net deep network.

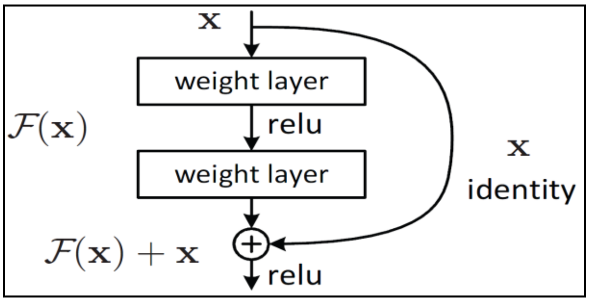


Fig 4. ResNet-18

3. RESULTS AND CONCLUSIONS

3.1 Performance Requirements

Table I. Performance Index

	precision	recall	f1-score	support
Mild	0.74	0.54	0.62	65
Moderate	0.69	0.83	0.75	190
No_DR	0.95	0.97	0.96	382
Proliferate_DR	0.58	0.52	0.55	58
Severe	0.82	0.37	0.51	38
accuracy			0.83	733
macro avg	0.76	0.64	0.68	733
weighted avg	0.83	0.83	0.82	733

The commonly used performance measurements in machine learning are accuracy, precision and recall.

Accuracy = (TP + TN)/ TP +TN + FP + FN

Precision = TP/ (FP+ TP)

Recall = TP/ (FN + TP)

where TP is True positive, TN is True negative, FP is false positive and FN is False negative

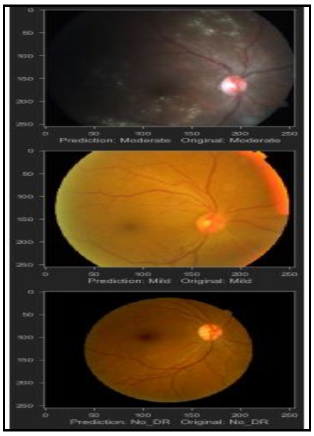


Fig 5. Predicted Output

3.2 Conclusion

Detecting diabetic retinopathy at an early stage is very significant to prevent from causing severe blindness. The symptoms that can be seen early for causing diabetic retinopathy are blurred vision, darker areas of vision, eye floaters and difficulty in recognizing colors. From the extracted features of the image, the grade of the disease can be classified as normal or abnormal. Also detecting and diagnosing the disease in initial stage can help patients from blindness and can decrease the effects to the eye. In the proposed system, the CNN model used is capable of identifying features from the images provided. CNN is very useful for clinicians of DR when datasets as well as networks improve continuously to provide classification that can be done in real-time.

REFERENCES

[1] S. Giraddi, S. Gadwal and J. Pujari, "Abnormality detection in retinal images using Haar wavelet and First order features," 2016 2nd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT), 2016.

[2] R, Nithya B , Reshma J , Ragendhu S and Sumithra M D "Diabetic Retinopathy Detection using Machine Learning" International Journal of Engineering Research &Technology (IJERT), ISSN: 2278-0181 IJERT, Vol. 9 Issue 06, June-2020.

[3] S. Chaudhary and H. R. Ramya, "Detection of Diabetic Retinopathy using Machine Learning Algorithm," 2020 IEEE International Conference for Innovation in Technology (INOCON), 2020.

[4] K. Bhatia, S. Arora and R. Tomar, "Diagnosis of diabetic retinopathy using machine learning classification algorithm," 2016 2nd International Conference on Next Generation Computing Technologies (NGCT), 2016.

[5] E. V. Carrera, A. González and R. Carrera, "Automated detection of diabetic retinopathy using SVM," 2017 IEEE XXIV International Conference on Electronics, Electrical Engineering and Computing (INTERCON), 2017.

[6] Y. S. Kanungo, B. Srinivasan and S. Choudhary, "Detecting diabetic retinopathy using deep learning," 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), 2017.