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Early Detection of Diabetic Retinopathy Using Deep Convolutional Neural Network

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Abstract - Diabetic Retinopathy is basically an eye oddity that is caused due to the long-term effects of a disease called diabetes. As this abnormality propagates it leads to blurry vision. The detection of DR using coloured and detailed images requires skilled doctors in order to identify the presence of minute but critical features which makes it a challenging and tedious task.

In our research we have used digital images for diagnosing DR. In this research we implemented a new technique in which the full image is divided into various regions and only the regions which are useful are taken into consideration for testing. CNN approach turns out to be very useful in terms of pace and precision. An accuracy of approx. 93.3% is obtained from CNN in this problem.

Key Words: CNN, DR(Diabetic Retinopathy)

1. Introduction

Diabetic Retinopathy is a disease which is generally caused due to long term effects of diabetes. A large percentage of population having diabetes for more than 10 years is diagnosed with some stage of the disease[1].And the major age group which is defected with DR is 20 - 70 years [2]. Also, the presence of DR largely depends on the time for which the respective person is diagnosed with diabetes . Researches shows that DR contributes nearly 5% of total cases of blindness[3].

The main problem with DR is that it do not cause any immediate vision loss, in fact it doesn't really shows any problem until it has reached to an advance stage.To identify DR we generally analyse the detailed eye images for any contusions or oozing. Normal technique for diagnosing diabetic retinopathy is usually time taking. Also professional doctors are required in order to detect the critical features from the retinal images.

A simplified and automated method for the detection of DR would be helpful for the people suffering from diabetes, so that DR can be recognized at an earlier stage. In today's time every country is having a very large portion of population which are affected from diabetes and subsequently from DR. So in that case our approach can be very helpful for the whole mankind.

2. Previous Work

Efficient work has already been carried out in extracting the blood vessel and the removal of optical disc[8]. But both these may sometimes give deviated results. We can use the technique of morphological closing and opening that can be used for the

removal of structures which may also produce some amount of abnormality.

Earlier the researchers had used ANN in their research paper for detecting the disease. They used this method by segmenting the blood veins in retina[1].We have considered there paper as the base paper from which the motivation was drawn to do research in this exciting field of biomedical engineering. The researchers finally arrived at a conclusion that ANN is giving very good results & the training of the NNs along with the algorithm was used to detect the DR at an early stage in the human beings, but the only limitation with this method was that they used only limited amount of images as input for testing and training which are taken from the standard database[1].

In the share of the work executed by different writers displayed in the past passages, there were sure downsides. Many of them have not considered unhealthy images, high computation time, consideration of small databases, noise effects were not considered. A no. of these advantages were taken into custody in our exploration work with various parametric info.

The short comings of the above-mentioned methods can be overcome through CNN techniques. CNN is a type of deep neural networks whose hidden layers has several convolution layers. CNN has the power to learn the features during its training phase. There is no need for extracting the features manually since it automatically extracts the features while passing through each of the layers. The hidden layer may include Rectified Linear Unit, which is an activation function, Convolutional Layer, Fully Connected Layer and SoftMax Layer[6].

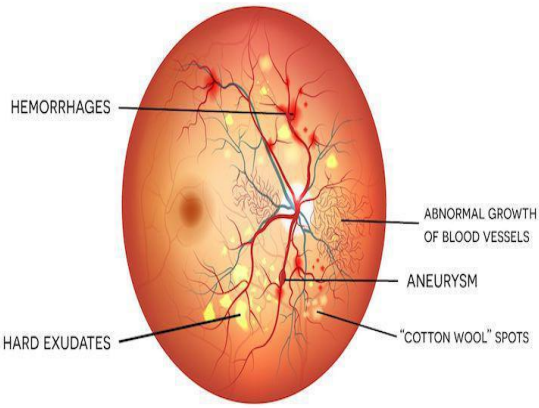

Fig.1: Picture to explain DR.

3. Proposed Method

CNN is a type of deep neural network which is extensively used for image recognition, computer vision, human pose estimation and many more[6]. For image classification CNN is used to group different images taken as input into an appropriate category. It contains a variety of hidden layers like ("Convolution Layer","Maxpool","Dropout","SoftMax", "Dense ","Max out",) which are used to extract the various attributes, properties and other valuable information from the input. Classification layer generally deals with the output of the CNN model.

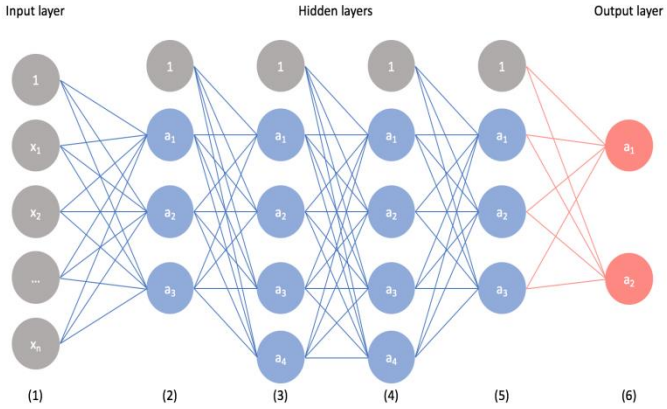

Fig.2: Basic structure of a Convolutional Neural Network [10].

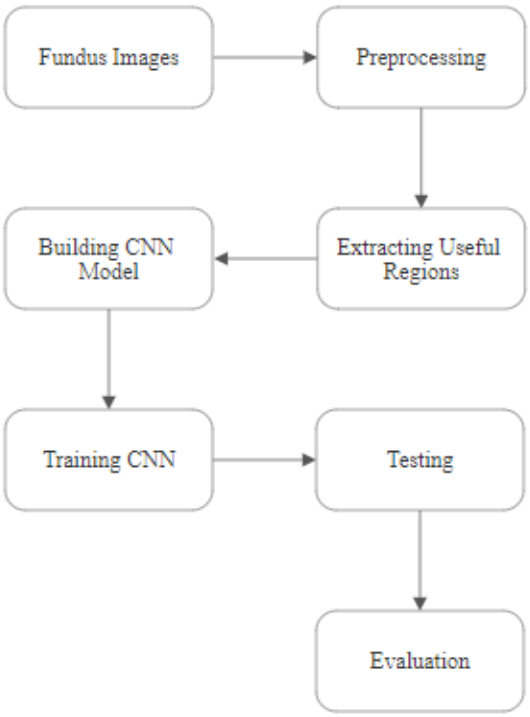

Fig.3: Basic representation of the methodology.

4. The Data set

The data set consists of 6,000 labeled high-resolution colour fundus retinal images,from which we have used 1,000 images for testing purpose and 5,000 images for training purpose.

The images have been open-sourced by Kaggle. A scale from 0 to 4 is presented by a doctor to measure the intensity or we can say severity of DR which is given as below[8].

0	No DR
1	Mild
2	Moderate
3	Severe
4	Proliferative DR

Table 1: Severity of DR on a scale of 0 to 4

We have formed our data set by taking different clicked images of right and left eye taken from different cameras , therefore we may observe a slight variance in between different images. One may also observe certain amount of noise in the input images. Also the input images may be out of focus, can be underexposed or over exposed, and more importantly the input images are of different resolution but these problems can be easily fixed using different prepossessing techniques for the images.

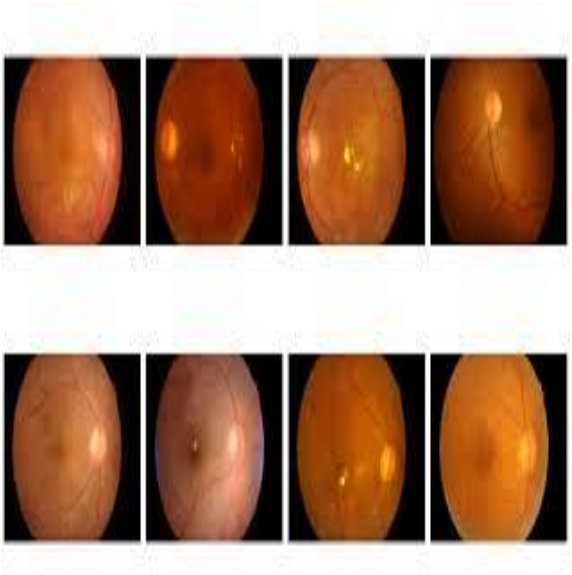

Fig.4: Sample Data set Images [8].

5. Performance Parameters

We have assessed the overall performance of our model in terms of accuracy.

Let,

P : number of patient found +ve with DR,

N : is the number of patients not affected with DR.

$T_0P^{(True\ Positive)}$: no. of patients with DR which are correctly diagnosed.

$F_0P^{(False\ Positive)}$: no. of patients without DR which is not correctly stated.

$T_0N^{(True\ Negative)}$: no. of patients that are not having any sign of DR .

$F_0N^{(False\ Negative)}$: no. of patients with DR which is not correctly classified.

We have used the following formula to find out how much accurate our model is[9].:

$Accuracy = (T_0P+T_0N)/(P+N)$

6.Results

In this research, it is not only important to measure the number of correctly and incorrectly classified test images, but it is also important to evaluate by how many classes the images were misclassified and to find out the accuracy score accordingly.
As a result, we obtain an accuracy score of 0.9331.

Author	Dataset	No. of images	Accuracy
STA-SMOTE [10]	e-optha	148	84.41
SMANet [11]	DRIVE, STARE	60	87
Segmentation [12]	Private dataset	63	92
CDR [13]	MESSIDOR, DRIVE. local dataset	1384	91
DWT [14]	local dataset	86	82.2
Deep Learning [15]	EyePACS	35126	83.68
DWT-ANN [16]	Private dataset	578	92.86
Our Method	Open Dataset on Kaggle	6000	93.31

Table 2: Comparison Results of the Proposed Method against other DR Detection Methods

7. Conclusions

This paper presents a basic design, architecture and implementation of Deep CNN for the detection and classification of diabetic retinopathy from coloured retinal images. This research involves CNN models, designing their architectures and finding the corresponding accuracy.
The best score of 0.9331 is obtained.

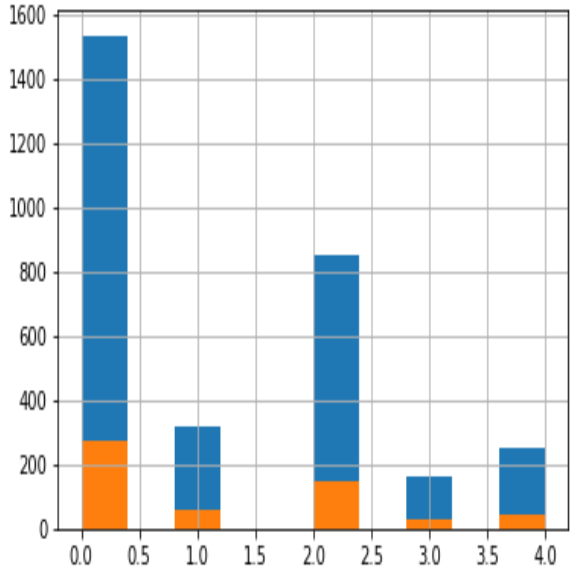

Fig.9: Visualization of Predictions.

8. Future Enhancements

Future Scope of this method or technique can be stated as below-
We can further fine tune the current network parameters to obtain a greater accuracy on single channel images.
• Using all the channels instead of a single channel enables the network to learn more features thereby decreasing the over-fitting through increasing complexity of data.
• Working with alternate image per-processing techniques in order to improve noise reduction.

9. References

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