Diabetic Retinopathy Eye Disease Detection Using Machine Learning

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Abstract

INTRODUCTION: Diabetic retinopathy is the name given to diabetes problems that harm the eyes. Its root cause is damage to the blood capillaries in the tissue that is light-sensitive in the rear of the eye. Over time, having excessive blood sugar may cause to the tiny blood capillaries that nourish the retina to become blocked, severing the retina's blood circulation. As a result, the eye tries to develop new blood arteries.
OBJECTIVES: The objective of this research is to analyse and compare various algorithms based on their performance and efficiency in predicting Diabetic Retinopathy.
METHODS: To achieve this, an experimental model was developed to predict Diabetic Retinopathy at early stage.
RESULTS: The results provide valuable insights into the effectiveness and scalability of these algorithms. The findings of this study contribute to the understanding of various algorithm selection and its impact on the overall performance of models.
CONCLUSION: The findings of this study contribute to the understanding of multiple algorithm selection and its impact on the overall performance of models' accuracy. By applying these algorithms, we can predict disease at early stage such that it can be cured efficiently before it goes worse.

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1. Introduction

In persons with diabetes, a disease known as diabetic retinopathy can result in visual loss and eventual blindness. It impacts the retina's blood vessels.
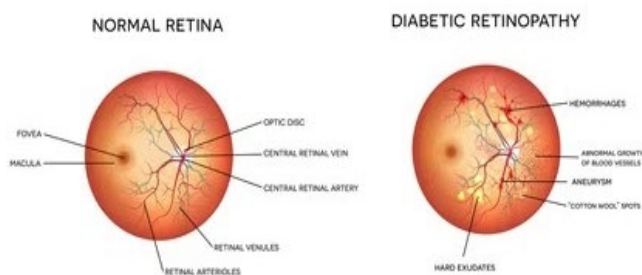

Figure 1. Diabetic Retinopathy and Normal Eye Retina

A blood sugar level that is consistently high can harm these blood vessels over time in two stages:

1.1 Pre-proliferative retinopathy

This stage of diabetic retinopathy occurs when blood's capillary system present at eye retina are injured due to excessive sugar levels. At this point, the retina starts swelling as a result of the injured blood vessels leaking fluid and blood into the eye, causes more severe and pervasive blood vessel alterations, including more extensive eye haemorrhage.

1.2 Proliferative retinopathy

The blocked damaged blood capillaries in eye's retina cause the development of abnormal new blood capillaries, which is the advanced stage of diabetic retinopathy. The retina may become severely swollen and scarred as a result of these new blood vessels, which could impair vision. "Machine learning" is that branch of AI (Artificial Intelligence) that lets computers in learning from various raw pieces of information, see repeats, and generate judgements.

Machine learning can evaluate huge datasets of retinal images and precisely identify the symptoms of diabetic retinopathy, making it beneficial in the detection of the condition. The detection and monitoring of diabetic retinopathy could become more accurate and efficient due to machine learning, which could result in better outcomes for people with this condition. In this research paper demonstrate the potential of machine learning algorithm like CNN ("Convolutional Neural Network"), KNN ("K-Nearest Neighbors"), SVM ("Support Vector Machine") for the detection of diabetic retinopathy.

2. Literature Review

Gulshan Varun, Peng lily et al. [1], in the study shows the evaluation a CNN model used a large dataset to train the model of retinal fundus images. According to the study, classic machine learning models for Diabetic Retinopathy classification, such SVM and KNN, can be outperformed by deep learning models.

R Revaty, B S Nithiya,et al.[2], in the study the authors suggest a method for classifying retinal images into various degrees of diabetic retinopathy by using random forest and image processing methods. The paper presents a promising approach for detecting diabetic retinopathy by applying machine learning methods. However, there are some limitations that need to be addressed in subsequent research, including the relatively small dataset, A short dataset may lead to overfitting and prevent the model from generalising to new data.

Just like these many studies have been done to assess how well various machine learning algorithms perform for Diabetic Retinopathy categorization those are depicted in the table shown below:

Table 1. Work done till now

Sr. No.	Topic	Author	Technique used	Remark
1.	"Automated grading of diabetic retinopathy using deep neural networks,2017"	Tien Yin Wong, Daniel S.W. Ting, et al. [3]	deep neural network-based algorithm.	Classify images into different grades of high accuracy and performed better than human experts in some cases.
2.	"Deep learning for automated diabetic retinopathy screening in telemedicine,2018"	Anuradha Krishnan Rajalakshmi, Subashini Ramesh,et al [4]	deep learning algorithm	Able to detect diabetes retinopathy accurately and can potentially be used in remote areas.
3.	"Automatic detection of diabetic retinopathy using image processing and machine learning techniques, 2017"	Manpreet Kaur Bhatia et al [5]	Methodology that integrates image_ processing, machine_ learning methods together.	High specificity in diagnosing diabetic retinopathy, and may be applied in primary care settings

No.	Title	Authors	Techniques	Description
4.	"Comparative Study of Diabetic Retinopathy Detection Using Machine Learning Techniques,2022"	Apoorva Hegde, K R Sumana [6]	Support_vector_machine, k_nearest_neighbours, random_forests	use different machine learning algorithms, suggests that combining various algorithms could enhance the effectiveness of detecting diabetic retinopathy overall.
5.	"A Review of Machine Learning Techniques for Diabetic Retinopathy Detection, 2018"	N. Ramesh and S. Viswanath	SVM (Support_Vector_Machine), k-NN(k_Nearest_Neighbors) and CNN (Convolutional_Neural_Network)	A thorough description of the most recent techniques used for retinopathy detection, and the difficulties are also highlighted.
6.	"Survey on Machine Learning Techniques for Diabetic Retinopathy Detection, 2019"	S. K. Singh and S. Kumar	SVM (Support Vector Machine), k-NN (k-Nearest Neighbors) and decision trees	gives a summary of the many machine learning methods used to diagnose diabetic retinopathy, also emphasised the significance of feature selection and data pre-processing.
7.	"Diabetic retinopathy detection using Gabor filter and support vector machine,2016"	V. S. Senthil Kumar and S. Karpagam	Gabor filter-based texture features and Support Vector Machine (SVM)	The method for detecting diabetic retinopathy presented in this research makes use of machine learning and texture analysis techniques, however more validation on larger datasets is needed to determine its efficiency.
8.	"Classification of diabetic retinopathy and normal retinopathy using CNN (Convolutional Neural Network) and SVM(Support Vector Machine),2019"	Dinial Utami Nurul Qomariah, Handayani Tjandrasa et al.	SVM (Support Vector Machine) and CNN (Convolutional Neural Network)	The method described in this paper—which combines CNN and SVM is a captivating approach for categorising retinal pictures, and the results are encouraging.
9.	"Application of a convolutional neural network for diabetic retinopathy detection using ultra-widefield and mydriatic fundus images,2021"	Liu Y, Chen Q et al.	Convolutional neural network (CNN) with ultra-widefield and mydriatic fundus images	A CNN using ultra-widefield and mydriatic pictures is shown in the study as a useful method for Diabetic Retinopathy detection in fundus images. The findings are encouraging and may have effects on the early detection and management of Diabetic Retinopathy.
10.	"Detection of diabetic retinopathy using machine learning, correlation analysis, and region of interest selection techniques,2020"	Nagraj, R. Acharya et al.	correlation analysis and ROI selection techniques, random forest	The random forest method showed the highest accuracy in Diabetic Retinopathy detection in fundus images, which is an encouraging outcome.

Machine learning is that branch of AI (Artificial Intelligence) that lets computers in learning from various raw pieces of information, see repeats, and generate judgements [7-9]. Machine learning can evaluate huge datasets of various other domains in addition to retinal images like hunting exoplanets, various other prediction and classification-based systems [10-19].
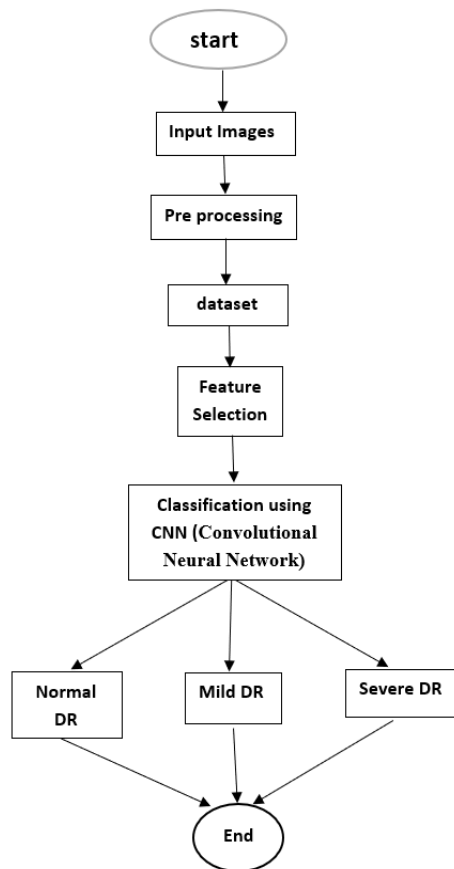
3. Proposed Model

Figure 2. Process workflow

A flowchart illustrating the approach is provided here to use machine learning to detect diabetic retinopathy. In the first phase, retinal images are collected into a database and put through pre-processing procedures to improve their quality by removing noise. A model that can distinguish between normal and abnormal diabetic retinopathy (both moderate and severe) can then be developed using machine learning using this well selected dataset.
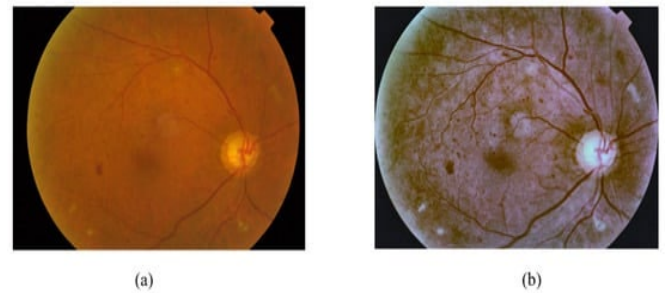
4. Results

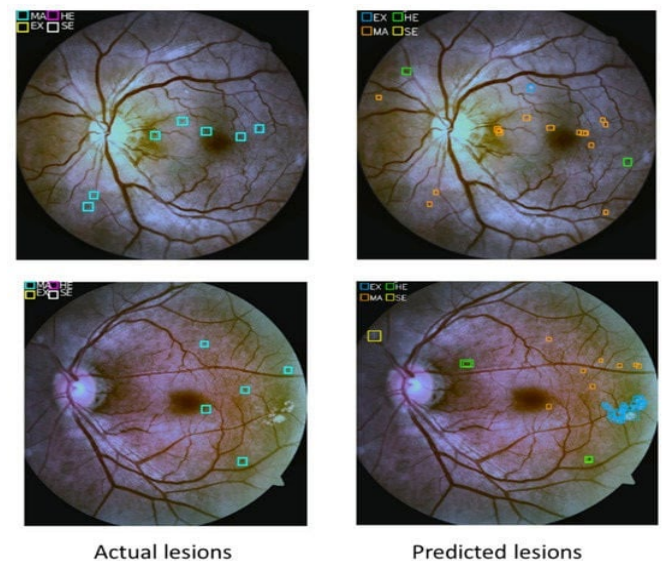**Figure 3.** The retina images preprocessing methods

Figure 4. Sample images of the (**a**) original image and (**b**) the preprocessing image

We used a publicly available dataset of fundus images collected of diabetes individuals for our study. The fundus images in the dataset were split into training and testing sets. The training set was then used to train CNN models.

```
conv_dw_13_relu (ReLU)      (None, 7, 7, 1024)      0

conv_pw_13 (Conv2D)         (None, 7, 7, 1024)      1048576

conv_pw_13_bn (BatchNormali (None, 7, 7, 1024)      4096
zation)

conv_pw_13_relu (ReLU)      (None, 7, 7, 1024)      0

dropout_1 (Dropout)         (None, 7, 7, 1024)      0

dense_1 (Dense)             (None, 7, 7, 7)         7175

=================================================================
Total params: 3,236,039
Trainable params: 3,214,151
Non-trainable params: 21,888
```

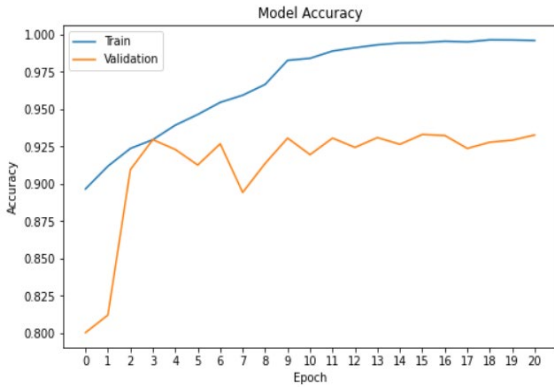**Figure 5.** Model output values after training for images

Figure 6. Model Accuracy

Epoch 1/10
    11/11 [==============================] - 142s
        13s/step - loss: 1.9439 - accuracy: 0.2191

Epoch 2/10
    11/11 [==============================] - 147s
        13s/step - loss: 1.9436 - accuracy: 0.2244

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.
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Epoch 9/10
    11/11 [==============================] - 137s
        13s/step - loss: 1.9385 - accuracy: 0.900
Epoch 10/10
11/11 [==============================] - 140s
13s/step - loss: 1.9363 - accuracy: 1.010

According to our results CNN is the best method for identifying diabetic retinopathy from fundus images.

6. Conclusion

In this paper, we show the use of CNN for the detection and categorization of diabetic retinopathy. CNN showed the best performance among Machine Learning techniques.

Our study demonstrates that machine learning models can help with the early diagnosis and treatment of diabetic retinopathy., which can lower the risk of blindness in diabetes patients.

The results of our study demonstrate the significant success of the suggested strategy and its scope in real-world medical settings.

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