



Classification of Diabetic Retinopathy using Convolutional Neural Network

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 30 Nov 2023	<i>Diabetic Retinopathy is a scenario in medical field which leads to the rise of damage of blood vessels in the retina which is due to diabetes mellitus. The suitable detection for this kind of problems and care to be done immediately in order to prohibit loss of sight in a person. Presently, diagnosing Diabetic Retinopathy manually is a time- consuming process where they require experienced clinicians to examine the digital-colored fundus images. Here, we have proposed a machine learning technology using Convolutional Neural Network (CNN) approach which has emerged as an operative productive tool in medical image examination for the classification and detection of Diabetic Retinopathy (DR) in real-world. The different layers which are used to detect the brain tumor are conv2D, Activation, MaxPooling2D, Dense and Flatten. The set used here considers 750 retinal images, with 600 training images and the test set considers 150 images with the accuracy of 82.75% which ran for 80 epochs.</i>
CC License CC-BY-NC-SA 4.0	Keywords: Diabetic Retinopathy (DR), Convolutional neural network (CNN)

1. Introduction

Diabetic Retinopathy is an inconvenience of eye, which is detected in diabetic patients. In this current lifestyle of everyone this is one of the significant foundations for sight disorders which is occurred because of the damage in blood vessels present in the retina, a delicate light tissue which makes it to become a common complication of Diabetes Mellitus. This occurs mainly to the Type 1 or Type 2 patients who is undergoing diabetes and are mostly susceptible to this type of problems. There are possibilities for this issue to happen if the duration prolonged by the patient is more leading to rise in blood sugar level and diabetes constantly. Monitoring the patients tormented by Diabetic Retinopathy has been a favoring for the studies and for the experimentation. The process of prior classification and identification of disorders of the images of retina square measures perpetually a heavy concern to the analysis of required community. Few works are printed to perform the classification of retinal pictures victimization some shallow learning techniques. If the method is performed by the clinicians, it's a really long technique. So, to unravel this in real time Computers are able to acquire a far faster classification trained once, by providing the flexibility to assist therapists in period classification. However, Deep Learning approach as an immense following which as a massive advancement in finding out visual connected issues. Therein one in all the variants of this technique is thought as CNN. It is a category of core of neural networks, typically mostly used to analyze visual mental imagery. This can be a medical imaging task with increasing diagnostic that is additionally referred to as invariant in shift, supporting the translation characteristics that are invariable and designing the weights that are used in this method. The requirement of applications for recommending system, for recognition of videos and images, classification of images, statistical monetary, tongue process and analysis of medical images. In the rapidly increasing of the resources of computation and information the ways of CNN-based techniques have enormously enhanced Diabetic Retinopathy performance of classification.

Literature Survey

The diabetic retinopathy is brought about by the levels of glucose content increment in which it prompts the occurrence of harmfulness inside the little veins of retina. Accordingly, the body of humans to endeavors that develops a fresh blood vessel on the region of eye that keeps the sustenance. The blood vessels which are fresh are powerless and likely to have a high certainty of spilling and dying. In paper [1] the outcome proposed, patients may encounter reformist vision issues from obscured vision to vision misfortune. [2] This paper examination has exhibited that the issue of five-class for public DR screening which is advanced towards the CNN methodology. The Convnet is utilized for catching spatial and worldly conditions. In [3] this test has acted in a managed way. In an overall standard, regulated learning techniques are prepared dependent on a preparation dataset which is appropriately named. This marked information is utilized to choose plausible best boundaries for the classifier. Finally, the choice or focus on information that fixes with the model which gives moderately the correct choices. [4] The paper has showcased that CNNs is been prepared for recognizing Diabetic Retinopathy in pictures of fundus and improve retinal fundus pictures in this investigation HSV V development and histogram adjustment for the methodology. Execution of the proposed technique Kaggle information utilizing 400 retinal fundus pictures at the base It has been assessed. In [5] paper, they proposed a viable DR programmed characterization framework dependent on computation of process for effective CNN structures. They assessed the exhibition generally on the two utilized characterization of datasets in DR. [6] The system proposed technique has the capacity in enhancing the quality of data used discounting of the area of data spacing of distribution in warehouse of data.[7] In this system using the pattern-based scheme and ranking algorithm which ranks the product reviews based on their features/product attributes using consumer-reviews. Along [10] with six helpful strategies the proposed structure accomplishes AUC of 0.959 for DR and 0.965 for RDR type of cases using Messidor dataset that beats the cutting edge. The [12] arrangement dependent on little squares is more exact. Accomplished affectability was 77%. They contrasted acquired outcomes with five different techniques with affectability esteems between 34 - 71 percent. In[13] The uncommon objective coding technique was proposed to incorporate the data about connection among anticipated and genuine degrees of infection. This strategy improved the grouping exactness of the inspected frameworks. Trial directed on the dataset showed the adequacy of neural based grouping frameworks.[14] The Given input image is preprocessed by ROI detection using Deep learning convolutional neural networking for image enhancement by usage of DR classifier.

Overview

Diabetic Retinopathy is a complication of an eye in the retinal regions, which is occurred in patients with diabetic state. In this current lifestyle of everyone this is extensively a major root for sight disorders which is due to damage in retinal blood vessels, a tissue which is delicate that makes it to becomes a Diabetes Mellitus common issue in the patients. We can come across few operations for the utilization of learning techniques for performing classification of images of retinal malignancy. If the process is performed by the clinicians, it is a very time-consuming method. In order to solve this in real time we can acquire a rapid classification which is possible by the computers on the basis of training period to the therapists which builds a confidence in them for aiding the patients. Moreover, the techniques of Deep Learning leave a massive response in clearing the visual problem at a greater success rate. In this learning techniques one of the frequently implemented methods is Convolutional Neural Network (CNN) that is applied here. In neural networks, it is a most commonly applied deep learning technique for analyzing visual imagery.

Hardware & Software requirements:

- Laptop with the minimum support of i5 8th generation processor, tensorflow, keras and kaggles diabetic retinopathy dataset.
- Keras is the main package for this model, which is an

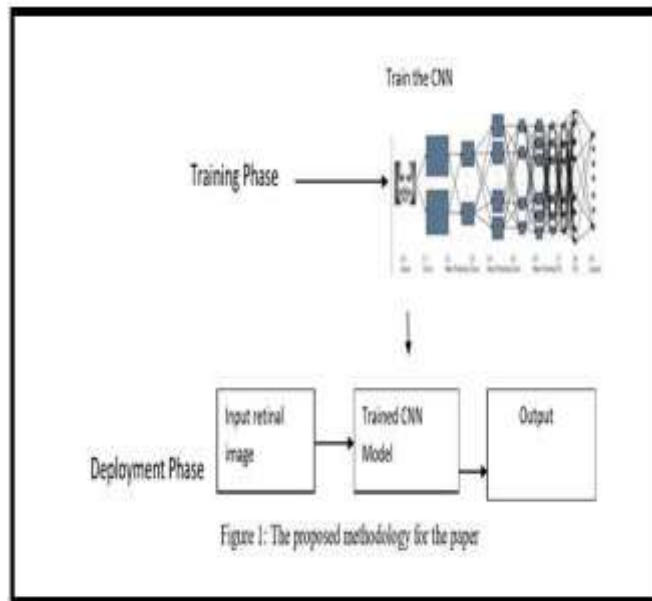
neural-networking space providing an open sourcing library that is inscribed in Python. The keras as the potential which can over shadow the uses of R, Microsoft Cognitive Toolkit, TensorFlow, Theano, or PlaidML.

2. Materials And Methods

The technique of CNN - Convolution Neural Network is a section of neural networking which gives an impact in the regulating of identification and classification of images. This extensively broadens the normal neural networking by building an operative functioning on convolution, sub-sampling and non-linearity. The prime motive of the convolution process is to extract and classify the taken input images based upon the features from the dataset. At the time of the event of convoluting the given images

several image processing effects, such as sharpening, blurring and detection of edge and exclusively it chooses metrics of small squares here. The methodology for the above proposed work chiefly comprises the following diagrammatic representation.

Fig1. The Proposed Methodology



- It is mapped out in such a way that it authorizes fast experimentation with Convolution neural networks, it focuses on being modular, user-friendly and extensible.
- A In the training phase, we build and train the CNN model by taking a huge collection of data. In the deployment phase, the given input is sent through the model for further testing.
- Which results in the formation of required output.

The main program for classification was implemented using CNN. At this point, the convolutional neural network was processing the previously prepared data, and with the method of cross validation it used 4 subsets for the training process and one for testing. After five iterations, the final result for the accuracy of the training and testing process was calculated in Fig1.

ALGORITHM:

1. Start
2. Loading data from the dataset.
3. Input images.
4. Data preprocessing.
5. Building CNN Model.
6. Training CNN.
7. Testing CNN.
8. Classification of DR.
9. Output.

```
model.summary()
```

Model: "sequential_3"

Layer (type)	Output Shape	Param #
conv2d_11 (Conv2D)	(None, 784, 784, 16)	448
max_pooling2d_11 (MaxPooling)	(None, 392, 392, 16)	0
conv2d_12 (Conv2D)	(None, 392, 392, 32)	4640
max_pooling2d_12 (MaxPooling)	(None, 196, 196, 32)	0
conv2d_13 (Conv2D)	(None, 196, 196, 64)	18496
max_pooling2d_13 (MaxPooling)	(None, 98, 98, 64)	0
flatten_4 (Flatten)	(None, 58824)	0
dense_8 (Dense)	(None, 64)	3774880
dense_9 (Dense)	(None, 1)	65
Total params: 37,772,449		

Fig2: Layers of CNN model

Convolutional Neural Networks is a class that belongs to deep learning, which is most commonly applied to image datasets. There are multiple types of commonly used layers in Convolutional Neural Networks as shown in fig3.

- **Convolution layer** – This part of layer focuses on the operation on images for the process of convolution bounded with a delimited padding and stride. Which is also the initial layer of operation that brings out the usage of numerous characteristics derived out of the input images. In the procedure of convolution process, the statistical operation for the process is carried out among the filter and input image of a specified size $M \times M$ of this layer. The resultant is named as the Feature map that provides information regarding the image about the edges and corners. Further, the feature map is shared out among the various layers to acquire knowledge about various features of the input image.
- **Pooling layer** - This layer focuses on reduction of the dimensionality of mapping features by specification of mask and execution of the operation. We learn how to move the mask in a specified stride on the entire image without weights accordingly. The prime motive of this layer is focusing on the decreasing of size of the mapping feature that is convolved for reduction of the computational costs. This is achieved by decreasing the attachments between layers and feature map operations.
- **Fully Connected layer** - This layer comprises of biases and weights with the neurons beside and is used for identification for connecting the two different layers with neurons. The input image from the preceding layers is flattened. This layer uses fully connected neural layers, which is at the final stalk of the networking neural. It is barely utilized presently because of the staggering number of frameworks it's utilizing.
- **Rectified Linear Unit Layer (ReLU)**- It is estimated following the process of convolution. Which is one of the frequently deployed activated functions which permits for building non-linear relationships by the help of neural networks that is accounted. In a provided matrix say (x), the ReLU places zero when the values are negative and remaining values are constant. Sigmoid, TanH which are also some alternate activation functions, but the most commonly used is ReLU, since it works faster comparatively, the efficiency is computationally good which permits the network to come together very rapidly.
- **Soft-Max Layer** - Soft-max is normally an activation layer that is carried out on the last layer of network which performs as a classifier. What happens here is the given set of input images undergoes classification and places themselves into distinct classes at this layer. One of the functions of soft max is that it uses the output of non-normalized for mapping the network layer to find the probability network allotment. The resultant from the fully connected layer of the last layer is assigned to soft-max layer, which converts it into possibilities. The soft-max here dispenses the decimal possibilities to all class in a problem of multi-class so that these possibilities gives a total that produces a result of 1.0. This permits the outcome to be demonstrated straightly as a possibility. In case of classification of binary problem, the function used is logistic and in the case of multi-classifications it uses soft-max.

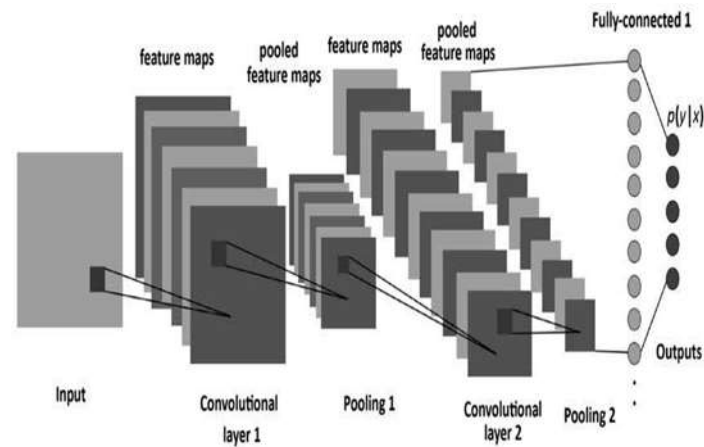


Fig3: Pictographic representation of layers

3. Results and Discussion

We have proposed a machine learning technology using the Convolutional Neural Network (CNN) approach that is immensely a productive tool in analyzing the medical required dataset images for the classification and detection of Diabetic Retinopathy in real-world. The different layers which are used to detect the brain tumor are conv2D, Activation, MaxPooling2D, Dense and Flatten. The training set used here considers 750 retinal images. The test set considers 150 images with the accuracy of 82.75% which we tried and improved compared to the references. Some of the resulting images after classification are as below.

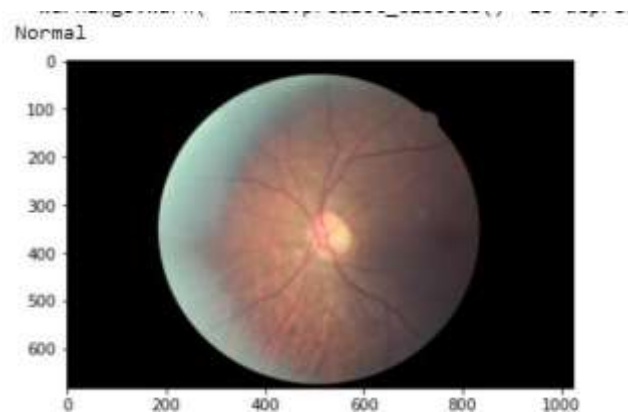


Fig4: No DR



Fig5: Moderate DR

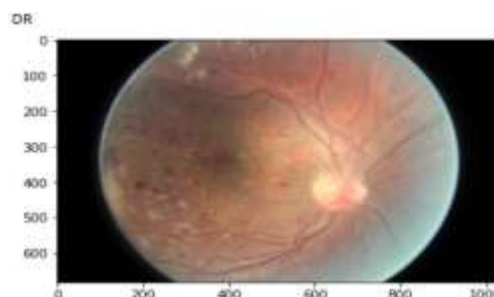


Fig6: DR

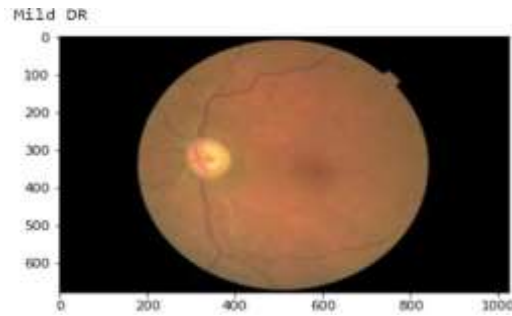


Fig7: Mild DR

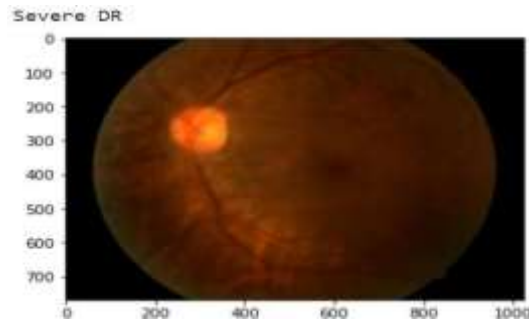


Fig8: Severe DR

0	No DR (Fig4.)
1	Moderate DR (Fig5.)
2	DR (Fig6.)
3	Mild DR (Fig7.)
4	Severe DR (Fig8.)

Table 1: Based on Severity scaling from 0-n.

Accuracy is calculated by the following $\text{Accuracy} = (T0P+T0N)/(P+N)$ where,

P is no. of patients with positive DR.

N is no. of patients with negative DR. T0P is true positive patients.

T0N is true negative patients.

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

Author	Dataset	No. of Images	Classification Accuracy
Kwasigroch.A[13].	EyePACKS	1000	79%
Carson Lam [14]	Messidor	1200	74%
Our method	Kaggle dataset	700	82.75%

4. Conclusion

A model is generated for the DR stages classification on the conditions derived from the severity of retinal pictures used in the model. It is examined for the performances of the approach by various metrics utilized in the process. By mainly considering the quality of heterogeneity of the images used in dataset. By considering all the motives of the model we can conclude that the proposed model is satisfactory. In addition, we can work on reaching more accuracy to the model by implementing various other complex techniques used in diagnosing the disorder. Like accommodating errors which is thrown out during the experimentation is taking place when capturing image will be useful for normalization methods to be more efficient during the development of the model.

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