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Diabetic Retinopathy Detection from Eye Fundus Images Using Convolutional Neural Network

S. Gayathri Devi Author[1], B.Nuthan Prasad Author[2], B. Vinay Kumar Author[3], V. Vinod Author[4]
[1,2,3,4] Member, Dept of Computer Science & Engineering, JB Institute of Engineering and Technology

Abstract: **Automated Diabetic Retinopathy (DR) detection, screening and diagnosis are critical to save vision loss of patients and assist the ophthalmologists in mass screening. DR screening aims at early treatment of the disease by detecting it before the stage progresses. Present DR analysis systems use digital fundus images for diagnosis reducing thehigh cost of manual computation. Researchersare continuously persisting for automated screening systems which can reduce the subjective interpretation for ophthalmologists.**

The proposed system consists of preprocessing, extraction of candidate lesions, feature set formulation, and classification. In preprocessing, the system eliminates background pixels and extracts the blood vessels and optic disc from the digital retinal image.

CNN model proposed in this paper provides an accuracy of 87.5% with cross entropy loss of 0.6370 with processing time of 1 minute and 23 seconds. Maximum accuracy improvement of 13% is achieved by the proposed approach over state of the art methods demonstrating preeminence in fundus image classification.

***Index Terms*— computer-aided diagnosis; convolutional neural networks; deep learning; diabetic retinopathy; diabetic retinopathy classification; diabetic retinopathy lesions localization;**

1.INTRODUCTION

Diabetic Retinopathy (DR) is a gradually progressing disease that leads to eye-sight loss at different severity levels. This prolonged situation may lead to acute blindness if left untreated. DR can be separated into two major stages: non-proliferative DR (NPDR) characterized by vitreous hemorrhage and proliferative DR (PDR) characterized by neovascularization. NPDR can be characterized into three sub-stages: mild, moderate and severe. Patients suffering from mild NPDR require regular screening, while appropriate laser treatment is needed for moderate/severe NPDR and PDR stage patients. Retinal blood vessels are damaged in NPDR stage leaking blood and fluid into the retinal surface causing anomalies like Microaneurysms (MAs), Haemorrhages (HMs), Hard Exudates (EXs) andCotton Wool Spots (CWs) Automated DR screening techniques aims at early treatment of the disease by detecting it before the stage progresses.

The DR screening programs are based on digital photography of retina which is less laborious and cost effective as compared to the manual image grading Researchers are continuously persisting for automated screening systems which can reduce the subjective interpretation and screening burdens for ophthalmologists. There exists a number of traditional machine learning based methods in the literature for DR severity grading. Segmentation approach was used to localize 12 distinct retinal layers combining shape, intensity and spatial information. Deep fusion classification network was trained to classify normal and DR grades and assess DR grades into mild/moderate grades. The research proposed a three stage DR detection and classification system for different DR lesions like MAs, HMs, EXs and CWs. Filter banks were used for lesion extraction, feature for each lesion candidate are extracted which is followed by lesion classification stage.

The results obtained are validated by comparing it with grading from ophthalmic experts. DR classification is of high diagnostic relevance, hence requires better interpretation approach. Although CNN based approaches have made significant contribution in DR diagnosis, but parameter tuning and class imbalance are some gaps which still prevails in their practical implementation. In this paper, deep learning based four different CNN architectures for DR classification using fundus images are proposed. The proposed approach over comes the class imbalance problem by fine tuning the network parameters. The performance of the proposed network is analyzed on a large retinal image dataset to validate its capabilities. The rest of this paper is organized as: Section 2 presents the preliminaries required for convolution neural networks, fundus image dataset, data augmentation and layered description of CNN architecture. Proposed Methodology is discussed in section 3 detailing the proposed CNN models

2. ARCHITECTURE

Architecture diagram explains the design of the project. It acts as a Blue Print for the project. It gives a brief idea of the project overview.

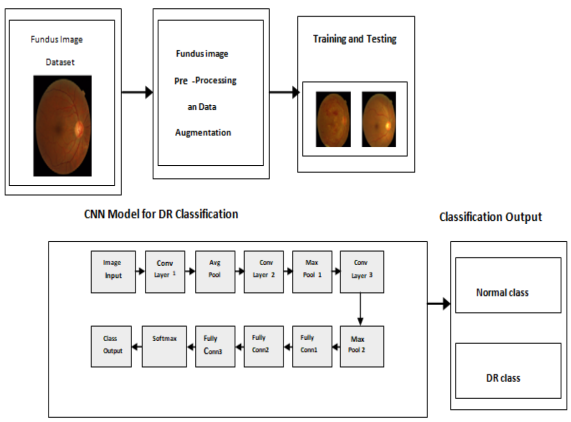

Fig1: Architecture of Diabetic Retinopathy Detection From Eye Fundus Images Using CNN

To develop a model, a Machine Learning algorithm is trained using a training data set. The ML algorithm makes a prediction based on the model when new input data is introduced.

The accuracy of the forecast is assessed, and if it is acceptable, the Machine Learning method is used. If the accuracy isn't good enough, the Machine Learning algorithm is retrained with a new batch of training data.

Building a Predictive model that can be used to discover a solution to a Problem Statement is part of the Machine Learning process. Assume you've been given an issue to address using Machine Learning to better understand the process. The below steps are followed in a Machine Learning process:

Step1: Define the goal of the problemstatement. We must now establish precisely what needs to be projected. The purpose of this scenario is to evaluate the possibility of rain using weather parameters. It's also a good idea to make mental notes on what kind of data you'll need to solve the problem and how you'll get there at this point.

Step2: DataCollection

• What type of data is required to tackle this problem?
• Is the data readily available?
• How do I obtain the information?

After you've figured out what kind of data you'll need, you'll need to figure out how to get it. Data can be collected manually or by web scraping. If you're a newbie trying to learn Machine Learning, though, you won't have to worry about acquiring data. There are plenty of data resources on the internet; simply download the data set and get started.

Returning to the issue at hand, the data required for weather forecasting comprises factors such as humidity, temperature, pressure, location, whether you reside in a hill station, and so on. Such information must be gathered and preserved in order to be analyzed.

Step3: DataPreparation

Almost never is the information you acquire in the appropriate format. Missing values, redundant variables, duplicate values, and other errors will be found across the data set. It's critical to eliminate such inconsistencies because they can lead to inaccurate calculations and predictions. As a result, you search the data set for discrepancies at this point and correct them immediately.

Step4: ExploratoryDataAnalysis

The initial stage of Machine Learning is Exploratory Data Analysis, or EDA. The purpose of data exploration is to discover patterns and trends in the data. At this point, all of the valuable insights have been gleaned, and the correlations between the variables have been identified.

For example, we discovered that many characteristics had a strong correlation between some variables in the dataset utilized in this work, Kaggle dataset (train labels.csv), and that this linked data can be deleted for better data processing. Such connections must be understood and mapped at this point.

Step5:Building aMachineLearningModel

The Machine Learning Model is built using all of the insights and patterns discovered during Data Exploration. The data set is always separated into two parts, training data and testing data, at this stage. The model will be built and analyzed using the training data. The model's logic is based on the Machine Learning Algorithm that is currently in use.

The type of problem you're trying to answer, the data set, and the problem's complexity all influence whatever algorithm you use. In the next sections, we'll go over the various types of problems that Machine Learning can address.

Step6:Model Evaluation& Optimization

Once the model has been developed using the training data set, it's time to put it to the test. The testing data set is used to determine the model's effectiveness and ability to accurately anticipate outcomes. After the accuracy has been calculated, any additional model enhancements can be made. You can use techniques like parameter tweaking and cross-validation to improve the model's performance.

Step7: Predictions

Once the model is evaluated and improved, it is finally used to make predictions. The final output can be a Categorical variable (eg. True or False) or it can be a Continuous Quantity (eg. the predicted value of a stock).

3. ALGORITHMS

Convolutional Neural Networks :

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics

A ConvNet is able to successfully capture the Spatial and Temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and reusability of weights.

4. MODULES

A. *Upload Fundus Dataset*: Upload Fundus Dataset module is used to upload dataset which contains FUNDUS images of 5 categories.
B. *Load Gan Model*: Load GAN Model Module is used to load GAN model and generate some synthesis images we can see GAN images and in above screen text area we can see GAN generated 200 images with size 32 X 32 and 3 means the images are in colour format not grey.
C. *Load Diabetic Retinopathy Prediction Model*:Load Diabetic Retinopathy Prediction Model module is used to generate and load prediction model to predict severity in GAN images we got message as to see black console to view model summary. CNN create multi layers and each layer has different image shape features.
D. *Generate Gan Image & Predict Severity:*Generate GAN Image & Predict Severity module to generate some images and predict severity of those images. Here GAN generate 200 images but it’s difficult to display all 200 images so I am display 10 random images from 200 GAN images. CNN predicted severity from images generated by GAN model. From 200 images I am displaying only 10 images. And we can see moderate class prediction also.

5. CONCLUSION

This paper presents four different CNN based architectures for DR classification so as to reduce the clinician’s burden of manual retinopathy screening. The trained model provides instant diagnosis of the diseased or non-diseased fundus using single image per eye. Class imbalance situation by fine tuning the network parametersis addressed in this paper. The proposed approach provides maximum 13% improvement over state-of-the-art techniques. In thefurther part of this research, the CNN network will be trained to distinguish between the mild, moderate and severe cases of DR. Moreover, the experimentation will be done on larger dataset for more subtle feature learning from fundus images. Thus, this work reveals that CNN can be trained to identify DR feature for better classification of abnormalities.

6. FUTURE ENHANCEMENT

In future we have plans to collect a much cleaner dataset from real Uk screening settings. The ongoing developments in CNNs allow much deeper networks which could learn better the intricate features that this network struggled to learn. The results from our network are very promising from an orthodox network topology. Unlike in previous methods, nothing specifically related to the features of our fundus images have been used such as vessels, exudate etc. This makes the CNN results impressive but in future we have ideas to cater our network towards this specific task, in order to learn the more subtle classification features.

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