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AUTOMATIC DETECTION AND GRADING OF DIABETIC RETINOPATHY FROM FUNDUS IMAGE USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT: *Diabetic retinopathy is a chronic disease that affects various parts of body including retina and causes injury within the tissues of retina of diabetic patients. Even, at its extremum, it'd cause permanent blindness to the patients that suffer from Diabetic retinopathy for a protracted period of your time. It is necessary to diagnose these patients very soon to cut back the severe impact of Diabetic retinopathy. Early identification of Diabetic Retinopathy is more essential to recover the eyesight and supply help for timely treatment. This paper describes the use of image processing and deep learning to diagnose diabetic retinopathy from retinal fundus images. The work proposed consisting of a feature extraction phase and a classification phase. In feature extraction phase we've got extracted the foremost appropriate features from digital fundus images by segmenting Blood Vessels and detecting Micro aneurysms. The classification was performed after image processing using the Convolution Neural Network. The obtained results show that the proposed method is incredibly efficient and successful to diagnose diabetic retinopathy from retinal fundus images.*

KEYWORDS

Diabetic Retinopathy, Fundus Image, Image Processing, Convolutional Neural Network, Deep Learning.

I. INTRODUCTION

The main causing of visual loss within the world is diabetic retinopathy. Within the initial stages of this disease, the retinal microvasculature is tormented by several abnormalities within the eye fundus like the microaneurysms and/or haemorrges, vascular hyper permeability signs, exudates, and capillary closures [1]. Ryan lee et.al reported that out of 285 million people with diabetic round the world one third of the people have symptoms of DR and therefore the number goes to extend drastically within the upcoming years.

The main components of a healthy retina are blood vessels, optic discs, and macula, and any variations in these components are symptoms of eye disease [2].Diabetic Retinopathy is also an on the spot consequence of harm of small blood vessels and neurons of the retina. it's going to find yourself in swelling and leakage of blood vessels, preventing blood from passing through and also sometimes growth of abnormal new blood vessels within the Retina. Spots or dark strings in vision, blurred vision, fluctuating vision, impaired visual modality, dark or empty areas in vision and vision loss are absolute symptoms of Diabetic Retinopathy [3]. The many signs and markers of diabetic retinopathy include micro-aneurysms, leaking blood vessels, retinal swellings, and also the expansion of abnormal new blood vessels and damaged nerve tissues. Generally, diabetic retinopathy is split into two levels; Proliferative Diabetic Retinopathy (PDR) and Non-Proliferative Diabetic Retinopathy (NPDR). NPDR is further subdivided into mild, moderate and severe counting on the amount and amount of bleeding and leaking areas [4]. It's an abnormal stage of diabetic retinopathy having leakage of blood vessels into the retina. Finally, the retina becomes wet and inflamed. Retinal abnormalities including, haemorrhages, exudates and micro aneurysms are often identified at the stage of NPDR. Haemorrhages are identified with the feel of blood dots on the retina, exudate may well be a basic sign of DR, soft exudates are exemplified as light yellow or white areas with distracted edges but hard exudates are represented as yellow waxy patches within the retina [5]. Initially they find yellowish objects then they find objects that have sharp edges using various rotated versions of Kirsch masks on the green component of the primary image. The yellowish objects with sharp edges are considered to be exudates [6].The existence of exudates within the retinal fundus photographs is one in all the foremost serious causes of DR.

Diabetic Retinopathy will be treated with methods like Focal laser treatment, Scatter laser treatment and Vitrectomy. Surgery often degrades or prohibits the event of diabetic retinopathy, but it's not a whole cure. Because it may be a lifelong condition, future retinal damage and vision loss is additionally possible. So, a correct diagnosis of the disease may be a necessity. For effective vessel segmentation and also to remove noise from the images, all the images are pre-processed [7]. Diagnosis methods like Fluorescein angiography and Optical coherence tomography which involves external fluid or dies to be applied on to the patients' eye after the Retinal Image is taken. But an automatic System which may immediately predict Diabetic Retinopathy with none external agent, could be a more leisurely and convenient method both for doctors and patients.

II. ALGORITHM DESCRIPTION

A Convolutional Neural Network is a group of deep neural network. A convolution is truly sliding a filter over the input. Motivated by human vision and designed to be robust against invariant transformations like scaling, translation, and rotations, convolutional neural networks became the actual standard for computer vision tasks within the recent decade. This deep learning revolution started with deep convolutional networks setting new state-of-the-art records on major image recognition tasks.

III. ARCHITECTURE DIAGRAM

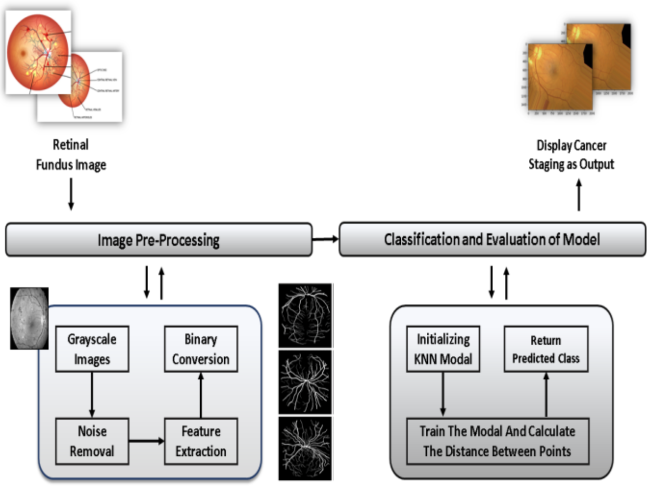

Figure 1: Pre-processing, Classification and Evaluation of Fundus Image

IV. METHODOLOGIES

THE DATASET

The High-Resolution Fundus (HRF) Image Database consists of 30 High Resolution Fundus Retinal Images out of which, 15 images are labelled as Healthy and 15 images are labelled as Diabetic.

PREPROCESSING

The retinal region is circular even though fundus images are rectangular. Therefore, retinal region masks must be utilized to select the region of interest in fundus images [8]. The fundus images used in the proposed work is taken from the Kaggle with different variations. So it is necessary to have a pre-processing mechanism. Thus, the following pre-processing method is performed to optimize the training and testing procedure:

Resizing and balancing the sample: All the images have been resized to 224 X 224 X 3. Since the Dataset consists of most of the images are of No DR category and less images from other categories, to obtain good accuracy for training the images has been classified into two categories namely '0' and '1'. 0 meant for No DR category and '1' meant for all the remaining categories. This would get a good classification even though the number of images is less in the No DR category.

Normalization: The intensity values of all images were normalized first remove bias values and to get a uniform distribution for the entire dataset.

Building CNN Model: The model type that selected for this study is the Sequential model that lets to build the model layer by layer in Kera's. Convolutional Neural Network (CNN) is a great way for image classification. CNN has chosen because it recognizes patterns available from a pixel image with visual patterns directly from pixel images with minimal pre-processing. The feature extraction has been done using the convolutional neural network and classification is done with fully connected and SoftMax layers. In this model new model is built to classify the images from the original dataset and then the reusability mechanism is used for the feature extraction steps and training will be carried out with the dataset. So the result is achieved with less computational resource and training time. The general architecture of the CNN model adopted with intermediate layers. To build this model, the convolutional layers were stacked first that extract features from input images and then followed by pooling layers to reduce the dimensionality of each feature map and keep only the significant features. To avoid overfitting, the Dropout layers were also included. Flatting layer then added which connected to the fully connected layer. Flatten layer create a single long feature vector to input it to the next layer "Fully Connected-Layer". Fully Connected-Layer followed by dense layers with dropouts to perform the classification based on extracted features by convolutional layers. This model was implemented in Python 3.7, in the environment using the Kera's package with TensorFlow 3.1 as backend and is run on Alienware Notebook.

TRAINING

Convolution layer: This layer applies the convolution operation on an image with a defined stride and padding.

Pooling layer: This layer is employed for reducing the dimensionality of feature maps by defining a mask and an operation to be performed, then moving the mask on the entire image in keeping with the stride defined. No weights are learnt during this layer.

Fully Connected layer: Traditional neural layers, used at the tip stem of the neural network. Used rarely nowadays thanks to the staggering number of parameters it uses.

Dropout layer: Used for reducing over-fitting. It randomly turns off some neurons at each pass during the training process.

Batch Normalization techniques have been used to standardize the input layer and this will stabilize the learning process and reduce the training epochs. For training the network, the dataset was portioned into 90:10 for training and validation respectively. Since it is a four-class classification problem, the model used 'categorical cross-entropy' as a loss function and also used 'Adam optimizer' to train the network. The area of hemorrhage detected along with number of lesions is employed as one of the features for decision based classification approach [9]. The model was run for 100 epochs with a batch size of 5. Learning rate was set to 0.00001 for Adam optimizer. The RELU activation function was used for the fully connected layers. The Dropout layer is fixed it with a rate of 0.25 which generally takes care of overfitting the network.

CLASSIFICATION

Once the model is saved, it loaded to make predictions. The model predicted on images that are not part of the training or testing splits. Due to the non-uniformity of the number of images available in Kaggle, the images were initially classified into 2 categories; later the probability values were calculated to classify the images to different classifications. The probabilities are set for the different classification of images is given in table 1. If the calculated probability value is less than or equal to 50 that test image will be classified as No DR, if it is between 51-65 it is of Mild category if the value falls in the range of 66-80 image is classified as moderate, if the probability value is in between 81-90 it's in a severe category and if the probability value is greater than 90 then that image will be classified as proliferative

Table 1: Probability values of different classifications

Level	**Probability values %**
No DR	0 - 50
Mild	51 - 65
Moderate	66 - 80
Severe	81 - 90
Proliferative	> 90

V. CONCLUSION

The early detection of diabetic retinopathy can significantly help to successfully recover from this disease. But the clinical diagnosis process is both costly and time consuming. The analysis of medical images in computer vision has very fast processing capability and can be given better prediction accuracy. In this system we have designed a computational model to predict the Diabetic Retinopathy (DR). The major advantage of this system is that it is well suited for analyzing the data with preloaded input to detect the accurate result with greater performance and consume a less amount of time in processing and predicting the results. Hence it helps doctors in starting the treatments early for the patients and also it helps in diagnosing more patients within a shorter period of time.

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