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DIABETIC RETINOPATHY USING DEEP LEARNING

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Abstract

Diabetic retinopathy is becoming a more prevalent disease in diabetic patients nowadays. Diabetic Retinopathy is one of the leading causes of blindness and eye disease in the working age population of the developed world. This project is an attempt towards finding an automated way to detect this disease in its early phase. In this project we are using supervised learning methods to classify a given set of images into 2 classes to verify that the patient has a scope for Diabetic Retinopathy. For this task we are employing various image processing techniques and filters to enhance many important features and then using neural for classification.

Keywords: Microneurysm; Hemorrhage; convolutional neural networks, MobileNetV2.

Introduction

Diabetic Retinopathy is a disease which is caused due to long term diabetes. It is an ocular manifestation of diabetes and around 80 percent of the population having diabetes for more than 10 or more years has some stages of the disease. Also the longer a person is in this disease there higher are the chances of having DR in his visual system. Research shows that it contributes around 5% of total cases of blindness. There are various factors affecting the disease like age of diabetes, poor control, pregnancy but research shows that progression to vision impairment can be slowed or averted if DR is detected in the early stage of the disease. One can see large no. of population suffering from the disease but still testing is done manually by trained professionals in real life which is quite time taking and lengthy process and usually due to miscommunication and delayed results eventually leads to delayed treatment and ignorance. So the aim of the project is to provide an automated, suitable and sophisticated approach using image processing and pattern recognition so that DR can be detected at early levels easily and damage to retina can be minimized.

Image Processing in computer science is very rapidly growing area of application which is used to process the digital images and manipulate through algorithms. It is also used to enhance and extract useful information from the images which undergone the process based on characteristics and features associated in that image. Also, Image processing plays an important role in our daily life and in the field of science which includes remote sensing, computer vision, face detection, finger print detection, feature extraction, biometric verification, signature recognition, biomedical image enhancement and medical palmistry. Image is the collection of pixels each holding a single value. The values held by the pixels are the intensity of light falling on that position in the image. The methodology in Image processing follows (1) Image acquisition, (2) preprocessing (3) edge-detection, (4) segmentation, (5) Image restoration and (6) output the sequence of image processing has an approach of storing the digital image on the system by sampling the image at regular grid. The color and intensity of each pixel is converted into numeric values and stored in the computer. The process of digital image processing is faster and cost- effective. No more fixing of chemical processing are needed to process images. To improve the quality of image and visual effect of people is the main purpose of image processing. It takes the lowquality input image, trains, classifies, and tests with various algorithms to display the image with high quality. In each image the accuracy level is indicated according to the processing aspects of each algorithm. This is an optimized workflow to reduce the time during the operations of image processing. In this paper, image processing in one of the medical field problems, is explained.

In addition, the integration of these deep learning advances into DR screening is not straightforward because of some challenges. First, there are a few end-to-end and multi-task learning methods that can share the multi-scale features extracted from convolutional layers for correlated tasks, and further improve the performance of DR grading based on the lesion detection and segmentation, due to the fact that DR grading inherently relies on the global presence and distribution of the DR lesions. Second, despite being helpful in DR screening, there are a few deep learning methods providing on-site image quality assessment with latency compatible with real-time use, which is one of the most needed additions at primary DR screening level and will have the impact on screening delivery at the community level.

According to the estimation of The World Health Organization (WHO) diabetics affected people are around 8.4%. About 90% of people are not aware of fundamental evaluation for Diabetic Retinopathy. Mostly people between ages 20 to 64 are affected to this blindness. The blood supply to the retina by vessels is susceptible to unrestrained blood sugar level. It also leads to crumbling and blockage of vessels due to insufficient supply of oxygen and cause severe injury. Microaneurysms are the earliest sign of Diabetic Retinopathy. There are two stages namely proliferative Diabetic Retinopathy (PDR) and non- proliferative Diabetic Retinopathy (NPDR). At the stage of NDPR the retinal blood vessels gets damaged and becomes wet and swollen. PDR stage occurs when abnormal blood vessels appear in various areas in retina. Detection at the early stage of this disease is very complex but essential. It's very important for regular screening of Diabetic Retinopathy to prevent further complication. Many researches from different medical industry are undergone for this purpose. It could be detected by machine learning and image processing. The retina of the diabetic affected patients is captured using fundus photography tool. It is also useful for monitoring the improvement or progression of diabetic retinopathy. Several image processing techniques includes filter, segmentation, classification and image enhancement has been developed for the early detection of Diabetic Retinopathy by the features of exudates, blood vessels, hemorrhages and Microaneurysms. These techniques are very useful to extract the features by sharpening, blurring, reducing noise etc. Convolutional Neural Network plays a major role for this disease detection. These techniques are explained elaborately below in this paper.

LITERATURE SURVEY

Application of higher order spectra for the identification of diabetes retinopathy stages: Feature extraction-based classification and DL has been used to classify DR. In Acharya et al. higher order spectra technique was used to extract features from 300 fundus images and fed to a support vector machine classifier; it classified the images into 5 classes with sensitivity of 82% and specificity of 88%. Different algorithms were developed to extract DR lesions such as blood vessels, exudates, and microaneurysms. Exudates have been extracted for DR grading. Support vector machine was used to classify the DIABETDB1 dataset into positive and negative classes using area and number of micro aneurysms as features.

Rethinking the inception architecture for computer vision: Feature extraction-based classification methods need expert knowledge in order to detect the required features, and they also involve a time consuming process of feature selection, identification and extraction. Furthermore, DL based systems such as CNNs have been seen to outperform feature extraction based methods. DL training for DR classification have been performed in two major categories: learning from scratch and transfer learning.

Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs: A convolutional neural network (CNN) was trained to classify a dataset of 128,175 fundus images into 2 classes, where the first class contains images with severity levels 0 and 1, and the second class contains levels 2, 3 and 4 . In an operating cut point picked for high sensitivity, had a sensitivity of 97.5% and specificity of 93.4% on the EyePACS-1 dataset which consists of 9963 images; it scored a sensitivity of 96.1% and a specificity of 93.9% on the Messidor-2 dataset; and in an evaluation cut point selected for high specificity, the sensitivity and specificity were 90.3% and 98.1% on the EyePACS-1, while 87% and 98.5% was scored on the Messidor-2, consecutively.

The survey papers used have various standalone methods to detect using fundus images. They have also given accuracy in terms of specificity and sensitivity excluding the processing time. Ankita Gupta, Rita Chhikara have compared the various machine learning algorithms experimental results. The parameters focused are like sensitivity, specificity, Area under Curve (AUC), Accuracy. The review detects DR approaching Blood vessels segmentation and Identification of lesions. The obtained results were also compared with deep neural network. Out of the various analyses best technique is provided. Moreover has provided high efficiency in detection of the desired features.

M.Kamaladevi et al., have proposed an automatic detection framework for Diabetic Retinopathy. They have extracted the features from the affected retinal images and detected them. Methodologies such as feature extraction is carried out and classified using classifiers such as Adaboost, Gradientboost, RandomForest, Voting classifier in the system. Over them prediction has remained predominated in RandomForest with a higher rate of accuracy.

Salman Sayed et al., have compared the detection of Diabetic Retinopathy in the fundus images using the models Probabilistic Neural Network (PNN) and Support vector machines (SVM).Initially through the preprocessing followed by machine learning techniques. Preprocessing techniques.

Traditional classification algorithms versus Convolutional neural network : In traditional methods, the process of training and testing flow starts from input of the image, then manual feature extraction followed by training and testing the model for detection and classification. But the advantage of convolutional neural network is that it does the feature selection and feature extraction by itself from end-to-end. So, there is no need to manually extract the features; instead input the images containing only those features and the rest is left up to the Convolutional Neural Network. The Preprocessed image is directly fed into the Convolutional Neural Network for the reason stated above. And it does all the feature selection and extraction by subsampling the parts of the image through each layer of convolution and pooling. Actually there are many numbers of convolution and pooling layer for better classification.

Finally, after many passes into these two layers it reaches the fully connected layer, the last layer of Convolutional Neural Network, where it builds the filters for classification of the image to normal and abnormal. Here stops the training part. The testing part also follows the same procedure but one more additional step it does is it performs an operation with the output of testing image values obtained from the fully connected layer with the values of filters which was constructed previously in the training part. If a match with higher score is found, then it’s classified accordingly. Then from the abnormal images, hemorrhages and Microaneurysms are segmented.

MobileNetV2: The introduced MobileNetV1, a family of general purpose computer vision neural networks designed with mobile devices in mind to support classification, detection and more. The ability to run deep networks on personal mobile devices improves user experience, offering anytime, anywhere access, with additional benefits for security, privacy, and energy

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consumption. As new applications emerge allowing users to interact with the real world in real time, so does the need for ever more efficient neural networks.

Today, we are pleased to announce the availability of MobileNetV2 to power the next generation of mobile vision applications. MobileNetV2 is a significant improvement over MobileNetV1 and pushes the state of the art for mobile visual recognition including classification, object detection and semantic segmentation. MobileNetV2 is released as part of TensorFlow-Slim Image Classification Library, or you can start exploring MobileNetV2 right away in Collaboratory. Alternatively, you can download the notebook and explore it locally using Jupyter. MobileNetV2 is also available as modules on TF-Hub, and pretrained checkpoints can be found on github.

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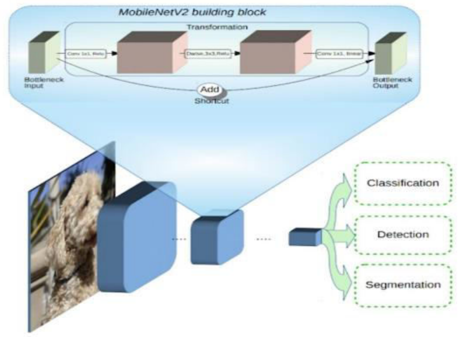
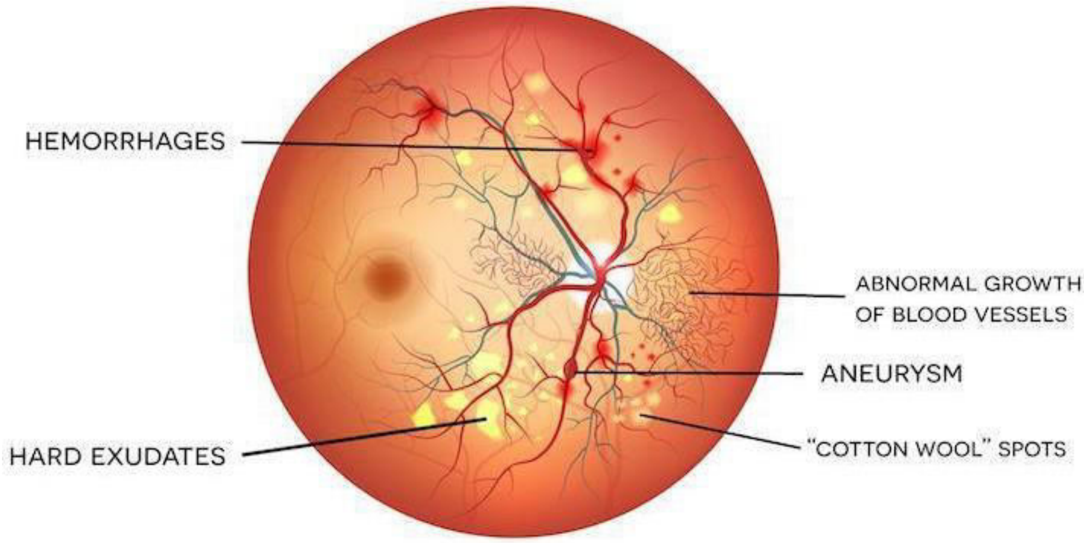
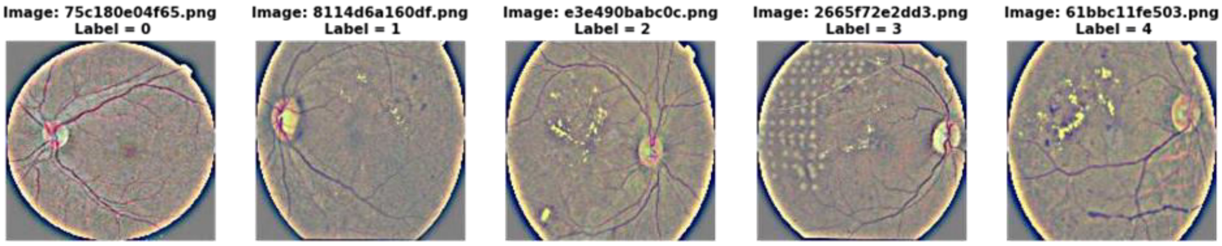


Overview of MobileNetV2 Architecture. Blue blocks represent composite convolutional building blocks as shown above.

Fig. MobileNetV2 model

Blue blocks represent composite convolutional building blocks as shown above. The intuition is that the bottlenecks encode the model's intermediate inputs and outputs while the inner layer encapsulates the model's ability to transform from lower-level concepts such as pixels to higher level descriptors such as image categories. Finally, as with traditional residual connections, shortcuts enable faster training and better accuracy. You can learn more about the technical details in our paper, "MobileNetV2: Inverted Residuals and Linear Bottlenecks".





Conclusion: This System has reached at a superior performance on account of the selected training algorithm, which is batch gradient descent with ascending learning rate Deep learning techniques that can learn from small dataset to categorize medical images should be utilized to classify DR, as this can be transferred to other medical image classification problems facing the challenge of insufficient training data. Experiments should be done to compare performances of other pre-trained deep convolutional Networks As we used Convolutional neural network methodology MobileNetV2, every input image will be classified with the highest accuracy assuring no misclassification happens. We first trained the CNN to recognize lines, edges, corners etc. from the retinal image followed by recognizing small parts of a single feature.

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