DIABETIC RETINOPATHY DETECTION

Project Report

CSE3013

Artificial Intelligence

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Abstract:

Diabetic retinopathy is a disease which occurs due to diabetic complication. It is caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina) which can lead to permanent blindness if left untreated.

Diabetic retinopathy is that the leading reason for visual impairment within the working- age population of the developed world, and affects up to four- hundredth of diabetic patients. The condition is calculable to have an effect on over ninety three million individuals. For individuals with correct detection and treatment, the harmful effects of diabetic retinopathy will be properly cured. But for those that square measure unable to go to a doctor either because of improper tending infrastructure the treatment is commonly troublesome, terribly overpriced, and time overwhelming. And determination this downside and police work diabetic retinopathy wouldn't solely save time, however cash yet. the necessity for a comprehensive and automatic methodology of diabetic retinopathy screening has long been recognized, and former efforts have created smart progress victimization image classification, pattern recognition, and machine learning. With photos of eyes as input, the goal of this capstone is to make a brand-new model, ideally leading to realistic clinical potential. Our implementation can use Google's open supply machine learning library TensorFlow. The Tensor Flow can build convolution neural networks which is able to take a retinal image because the input, analyse it and learn the characteristics of associate eyes that shows the signs of diabetic retinopathy. this can be recurrent for many totally different retinal pictures, so optimizing and increasing the potency of our model to predict higher results.

One of the essential challenges is early detection, which is very important for treatment success. Unfortunately, the exact identification of the diabetic retinopathy stage is notoriously tricky and requires expert human interpretation of fundus images. Simplification of the detection step is crucial and can help millions of people. Convolutional neural networks (CNN) have been successfully applied in many adjacent subjects, and for diagnosis of diabetic retinopathy itself. In this paper we purpose a deep learning method for stage detection of diabetic retinopathy by single photography of the human fundus using multistage approach to transfer learning based on APTOS 2019 Blindness Detection Dataset.

Introduction:

Diabetic Retinopathy is one of the leading causes of blindness when left undetected. In order to detect and prevent this disease from causing complete blindness or to check it is difficult in case of lack of qualified doctors and equipment. As such the goal of this project is to implement the modern technologies to develop a system that can automatically screen image for disease and measure the severity of the disease. This can be achieved by building a Convolutional Neural Network (CNN) model that can compare the patient eye image and estimate the condition based on this model. To develop this CNN model we can use any dataset here APTOS2019 dataset is used which consist of sufficient training images for various severity scale. The various severity parameter scale is given as:

0- No DR
1- Mild, the earliest stage, where only microaneurysms can occur
2- Moderate, a stage which can be described by losing the blood vessels' ability of blood transportation due to their distortion and swelling with the progress of the disease
3- Severe, It results in deprived blood supply to the retina due to the increased blockage of more blood vessels, hence signalling the retina for the growing of fresh blood vessels
4- Proliferative DR, the advanced stage, where the growth features secreted by the retina activate proliferation of the new blood vessels, growing along inside covering of retina in some vitreous gel, filling the eye.

Related Work:

DETECTION AND CLASSIFICATION OF DIABETIC RETINOPATHY USING MACHINE LEARNING

During this paper, various ideas associated with an automatic DR system to detect and classify the DR malady at an early stage are pitted against each other. At an early stage to classify DR pre-processing, segmentation, feature extraction and classification techniques are used. The details equipped during this paper square measure the work done by numerous authors in shell. the most contribution of this survey paper is to vitalize additional researchers to prosper and enhance probable proposal for DR detection and classification victimization totally different technique and methodology. This paper acts as an organized guide for DR analysis.

https://www.researchgate.net/publication/343253756_DETECTION_AND_CLASSIFICATION_OF_DIABETIC_RETINOPATHY_USING_MACHINE_LEARNING_-A_SURVEY

Diabetic retinopathy detection using deep convolutional neural networks

Diabetic retinopathy is once harm happens to the tissue layer thanks to polygenic disease, that affects up to eighty % of all patients World Health Organization have had polygenic disease for ten years or a lot of. The experience and instrumentality needed are typically lacking in areas wherever diabetic retinopathy detection is most required. Most of the add the sector of diabetic retinopathy has been supported malady detection or manual extraction of options, however this paper aims at automatic identification of the malady into its completely different stages mistreatment deep learning. This paper presents the look and implementation of GPU accelerated deep convolutional neural networks to mechanically diagnose and thereby classify high- resolution retinal pictures into five stages of the malady supported severity. the only model accuracy of the convolutional neural networks bestowed during this paper is zero.386 on a quadratic weighted letter metric and enfeebling of 3 such similar models resulted during a score of 0.3996.

https://ieeexplore.ieee.org/abstract/document/7914977

D. Doshi, A. Shenoy, D. Sidhpura and P. Gharpure, "Diabetic retinopathy detection using deep convolutional neural networks," *2016 International Conference on Computing, Analytics and Security Trends (CAST)*, 2016, pp. 261-266, doi: 10.1109/CAST.2016.7914977.

Artificial intelligence in diabetic retinopathy: A natural step to the future:

Use of artificial intelligence in medicine in an evolving technology which holds promise for mass screening and perhaps may even help in establishing an accurate diagnosis. The ability of complex computing is to perform pattern recognition by creating complex relationships based on input data and then comparing it with performance standards is a big step. Diabetic retinopathy is an ever-increasing problem. Early screening and timely treatment of the same can reduce the burden of sight threatening retinopathy. Any tool which can aid in quick screening of this disorder and minimize requirement of trained human resource for the same would probably be a boon for patients and ophthalmologists. In this review we discuss the current status of use of artificial intelligence in diabetic retinopathy and few other common retinal disorders.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6611318/

Padhy, Srikanta Kumar, Brijesh Takkar, Rohan Chawla, and Atul Kumar. "Artificial intelligence in diabetic retinopathy: A natural step to the future." Indian journal of ophthalmology 67, no. 7 (2019): 1004.

Diabetic retinopathy detection through deep learning techniques: A review

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time-, effort-, and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems. Recently, deep learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. Convolutional neural networks are more widely used as a deep learning method in medical image analysis and they are highly effective. For this article, the recent state-of-the-art methods of DR color fundus images detection and classification using deep learning techniques have been reviewed and analyzed. Furthermore, the DR available datasets for the color fundus retina have been reviewed. Difference challenging issues that require more investigation are also discussed.

https://www.sciencedirect.com/science/article/pii/S2352914820302069

Alyoubi, Wejdan L., Wafaa M. Shalash, and Maysoon F. Abulkhair. "Diabetic retinopathy detection through deep learning techniques: A review." *Informatics in Medicine Unlocked* 20 (2020): 100377.

Automated diabetic retinopathy detection in smartphone-based fundus photography using artificial intelligence

The role of artificial intelligence (AI)-based automated software for detection of diabetic retinopathy (DR) and sight-threatening DR (STDR) by fundus photography taken using a smartphone-based device and validate it against ophthalmologist's grading. Three hundred and one patients with type 2 diabetes underwent retinal photography with Remidio 'Fundus on phone' (FOP), a smartphone-based device, at a tertiary care diabetes centre in India. Grading of DR was performed by the ophthalmologists using International Clinical DR (ICDR) classification scale. STDR was defined by the presence of severe non-proliferative DR, proliferative DR or diabetic macular oedema (DME). The retinal photographs were graded using a validated AI DR screening software (EyeArtTM) designed to identify DR, referable DR (moderate non-proliferative DR or worse and/or DME) or STDR. The sensitivity and specificity of automated grading were assessed and validated against the ophthalmologists' grading.

Rajalakshmi, Ramachandran, Radhakrishnan Subashini, Ranjit Mohan Anjana, and Viswanathan Mohan. "Automated diabetic retinopathy detection in smartphone-based fundus photography using artificial intelligence." *Eye* 32, no. 6 (2018): 1138-1144.

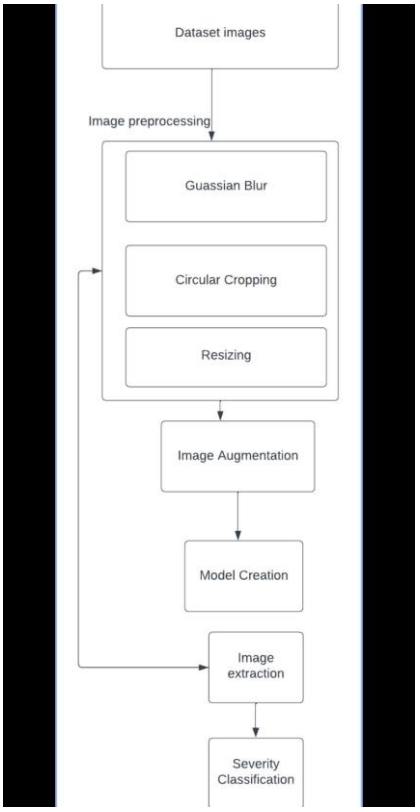
- This system can be used in rural and remote area where there is lack of high tech medical testing equipment.
- This system acts as an assistant to a medical person to verify the test result due to its high accuracy compared to human observation.
- It makes DR testing easy as anyone can test their eyes by uploading the picture of their eyes as such this also avoids the need to pay doctor testing fee in poorer parts.
- This system has high scope of development as it can be further improvised from just a DR detection system to also provide treatment plan and proper guided instruction based on their

Tools and Technologies used:

1. Python
2. Tensorflow
3. Keras
4. OpenCV

Proposed System Process Flow

As we can see below, the Research paper uses a Multi Task learning Model (it parallely does training for Regression, Classification, Ordinal Regression). This way it can use single Model and since first layers would anyway learn similar features, this architecture is implemented to reduce training time (instead of training 3 seperate models). For the Encoder part, we could use any Existing CNN architecture — ResNet



Working methodology:

Selecting Image:

The images we use in this project are all retinal images taken using fundus photography. However each photos are taken independently as such all of them have differences, some are underexposed, overexposed, out of focus, dim, high brightness as such it gets hard to compare all of them between each other due to such variation as such further work on the image is needed.

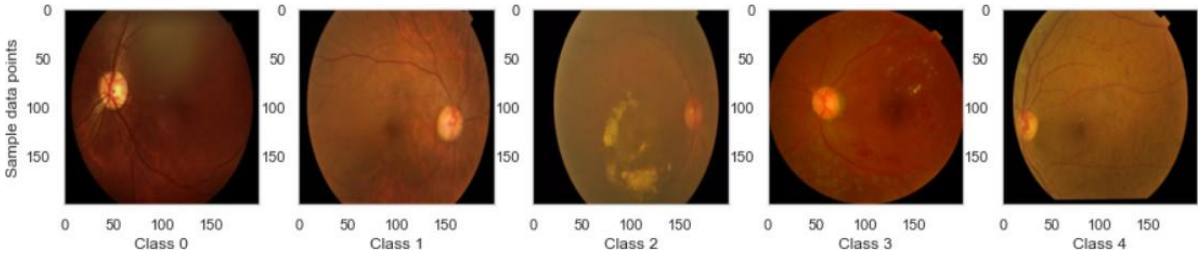


Image processing:

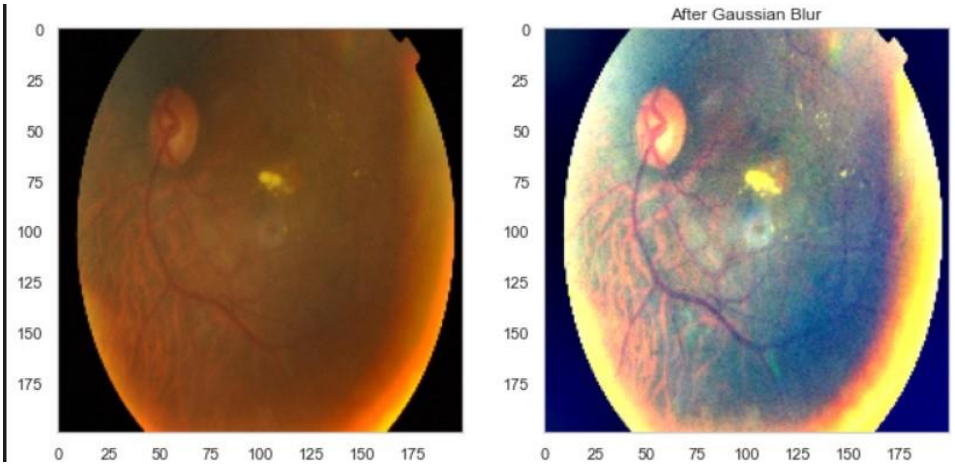
In order to make the image sharper to extract the needed data further processing is needed, as such we applied different image processing technique utilizing OpenCV library namely:

Gaussian Blur:

In image processing, a Gaussian blur (also known as Gaussian smoothing) is the result of blurring an image by a Gaussian function. The visual effect of this blurring technique is a smooth blur resembling that of viewing the image through a translucent screen. Gaussian smoothing is also used as a pre-processing stage in computer vision algorithms in order to enhance image structures at different scales. The mathematic formula behind guassian blur is:

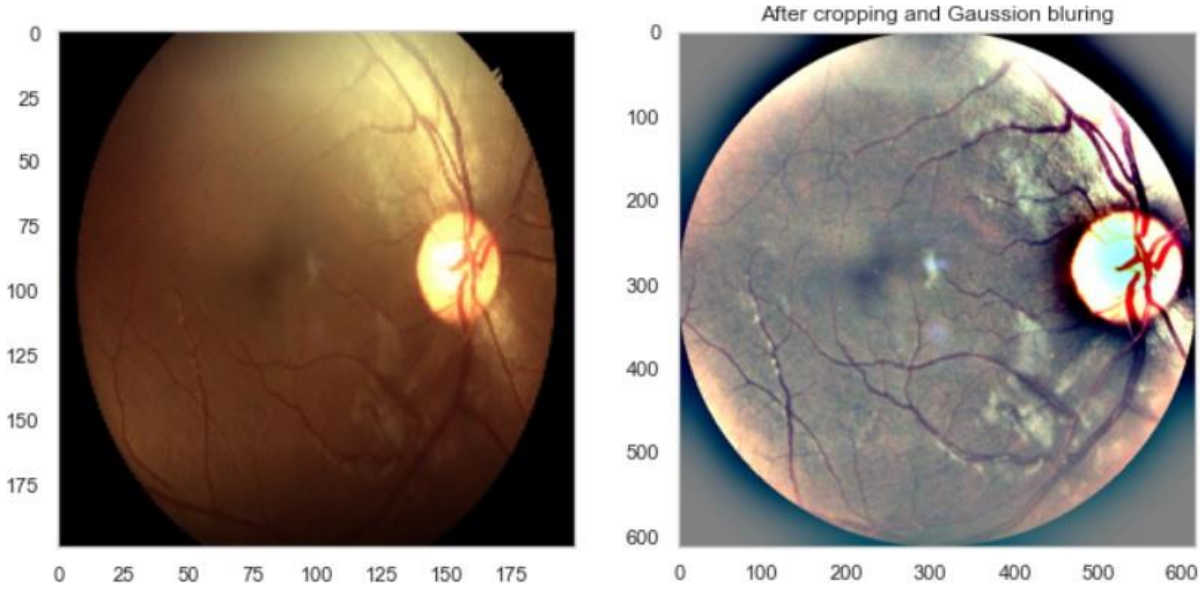
$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

In our project we applied guassian blur using a predefined function in OpenCV library named GaussianBlur as cv2.GaussianBlur(img,(0,0), 30)



Circular Cropping Gaussian Blur:

After cropping the image in gray scale and applying guassian blur the image we get is highly detailed which allows us to observe distinct patterns present in the image to observe the DR. Here we defined our own function to apply circular cropping and further used guassian blur over it to obtain the given image.

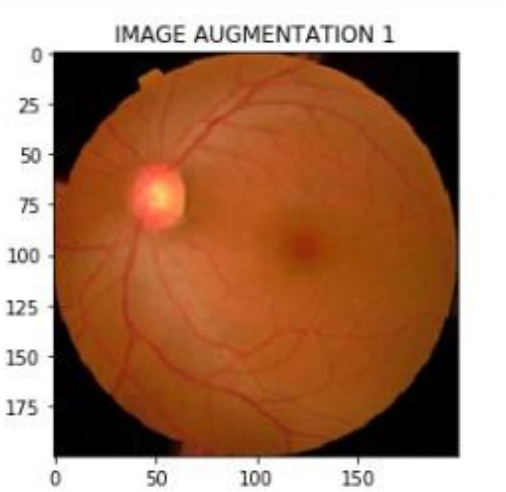


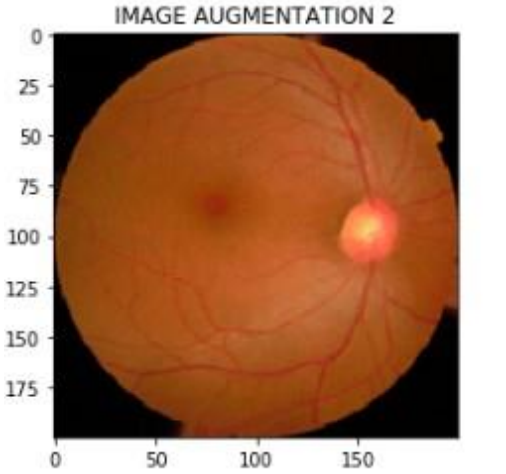
Resizing and storing:

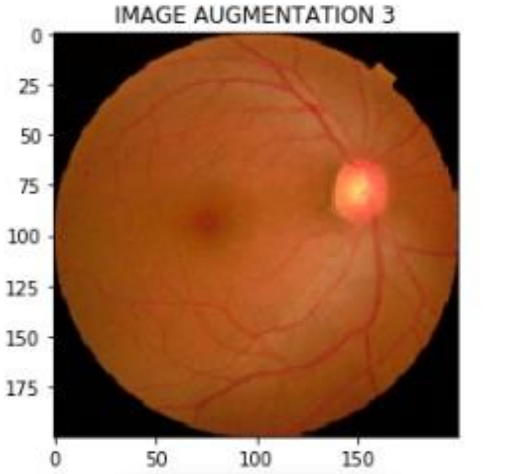
These images which have been processed have to be stored in order to use later on but these images are heavy and will occupy a lot of space we resize the images to reduce the image sizes without compromising the detail for which we use multicore threading which utilizes the all the cores present in the machine and allows us to resize and store the images in a small period of time. For this multithread processing we require ThreadPool library in python.

Image Augmentation:

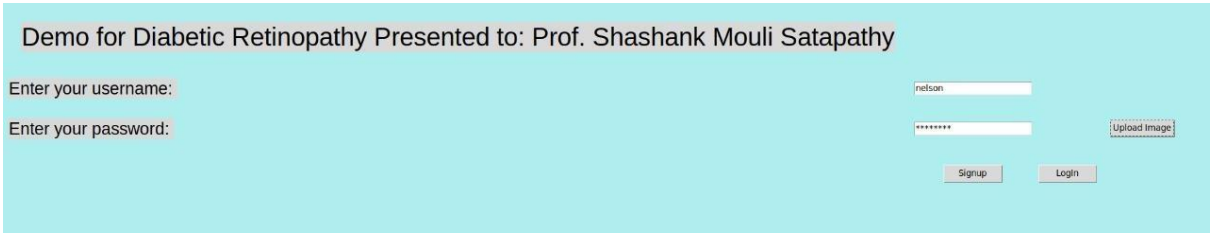
Data augmentation is one of the most step to generate uniqueness in the data present by creating additional images from the dataset by rotating, padding, cropping, flips to make it generalized. For this we use ImageDataGenerator function present under keras library



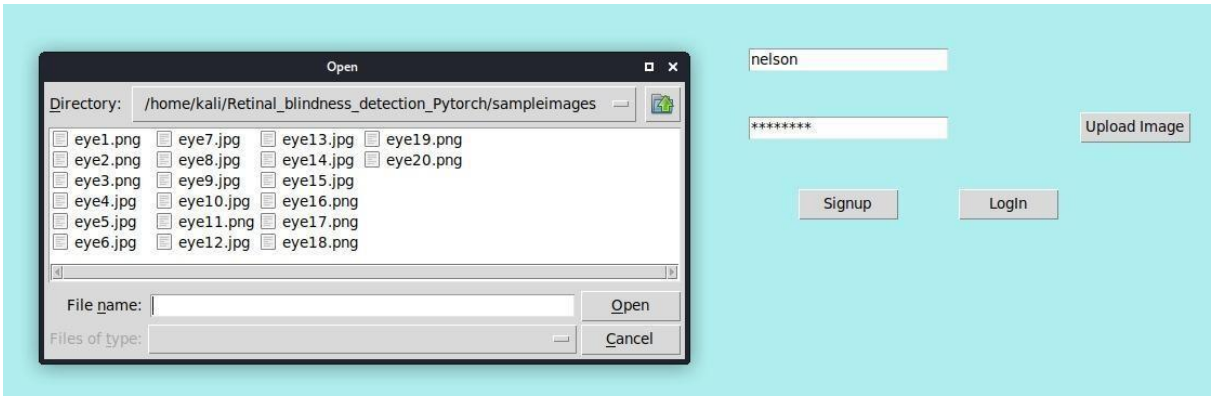




Implementation Results and User Interfaces:



Here we have our GUI application dashboard which is opened when we execute our file which allows ease of access to end users



Here we are able to select our images to be processed

Once we submit our image a prediction is made by our application to give the user the results

Comparative Analysis:

Comparing to the research paper where the accuracy obtained was 62.34% but as we can see, only within 8 Epochs, we get good Accuracy Score — Close to 78.97% on Validation dataset and 87.14% in Train dataset.

The obtained model is then saved and used for testing the DR images.

Conclusion and future scope:

Here we have used AI to create a model to detect the diabetic retinopathy in a simple GUI app format.

This project can later be further improvised to provide real time doctor support as well as we can extend this diagnosis from not only to Diabetic Retinopathy but to the detection of other diseases as well by implementing the modern AI techniques. This project was the first time hand on experience we had on AI as such it gave us a lot of knowledge to grown in this field.

References:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6611318/
- https://www.sciencedirect.com/science/article/pii/S2352914820302069
- https://ieeexplore.ieee.org/document/7279547 https://scholar.google.com/scholar_lookup?journal=J+Med+Syst&title=Automated+identification+of+exudates+and+optic+disc+based+on+inverse+surface+thresholding&author=H+Yazid&author=H+Arof&author=HM+Isa&volume=36&publication_year=2012&pages=1997-2004&pmid=21318328&
- https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm604357.htm

Appendix:

https://github.com/NelsonDayan/AI-Project