Harnessing Feature Extraction Techniques alongside CNN for Diabetic Retinopathy Detection

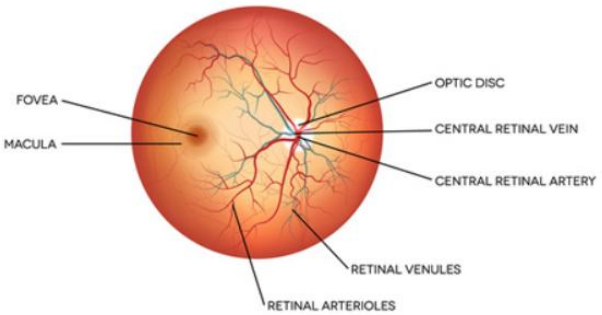
Fatima Patel, Saniya Shinde, Shivani Lingwat, Komal Bavle, Shweta Koparde

Abstract*: Diabetes mellitus is a disorder that inhibits your body from properly using the energy from the food you consume. The blood vessels and blood are responsible for the transport of sugar. A hormone called insulin helps cells to take in sugar to be used as energy. Deficiency in insulin causes the disease of diabetes mellitus. One of the side effect of diabetes mellitus is diabetic retinopathy. Diabetic retinopathy is the medical condition that causes the principal vision or in rare cases entire vision loss. Diabetic retinopathy has frequent occurrences in people among 20 to 60 years. Addressing this problem, we have developed an application that saves time and gives the result of the stage of the disease. This research paper presents a CNN based system that classifies the patients in four classes as 0-no DR, 1-Mild DR, 2-Moderate DR, 3-Severe DR. The system takes the input as an image taken from a fundus camera. Image processing techniques and machine learning algorithms are used for feature extraction. The Automated screening of the retinal images would assist the doctors to easily identify the patient's condition more precisely. With this we can easily distinguish between normal and abnormal images of the retina, this will reduce the number of inspections for the doctors.

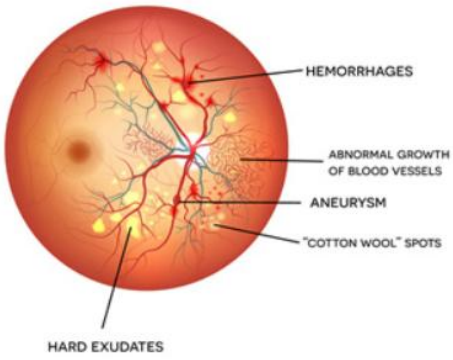
***Keywords*: Diabetic Retinopathy, Image processing, K means clustering algorithm, Convolutional neural networks.**

I. INTRODUCTION

Diabetic Retinopathy is a chronic disease that occurs in people suffering from Diabetes Mellitus. It is an eye condition that leads to blindness and vision loss. It most commonly affects people suffering from diabetes for a prolonged time. Diabetic Retinopathy is caused due to the raised blood glucose level. It damages the light-sensitive part of the eye that is the retina. The Retina is a sensory membrane that lines the innermost layer at the back of the eye. The retina is responsible for the reception of light that the lens has focused on. It sends the neural signals to the brain for visual recognition through the optic nerve. The disease damages the retina. The retina develops new minute blood vessels abnormally, hard and soft exudates are formed, blood vessels bursts, there is leakage of blood in the eye, extra fluids are formed, the tissues in the retina are swollen and red spots on the retina may be developed known as micro aneurysms. This leads to blurred vision and in rare cases complete vision loss if not treated in the early stages.



(a)



(b)

Fig. 1. (a)Normal Eye (b)Diabetic Retinopathy

There are five stages of diabetic retinopathy. If detected at the early stages can be cured properly and vision loss can be avoided. In the case of the latter stages, it becomes difficult to treat the disease. The symptoms are not easily detected in patients suffering from diabetic retinopathy. Thus early detection of DR and medical treatment is vital. The symptoms may include blurred vision, impairment of vision, bad night vision, floaters that float in vision area, sudden loss of vision, or blindness. People who are experiencing high blood pressure, high blood glucose levels, someone who smokes regularly, or someone who is pregnant is at a high risk of developing diabetic retinopathy.

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To prevent DR regular eye examination is important. The first stage is also called background retinopathy. Tiny bulges or red spots are developed on the retina. These bulges are called micro aneurysms. In the Moderate DR stage, the blood vessels are swollen due to which proper nourishment to the eye is not been provided. In Severe DR, the blood vessels become more swollen, and hence less blood is provided to the retina. Due to which new blood vessels are formed. And in the last stage that is proliferative DR, blood is leaked into the retina and extra fluids are formed called hard exudates that are deposited on the retina.

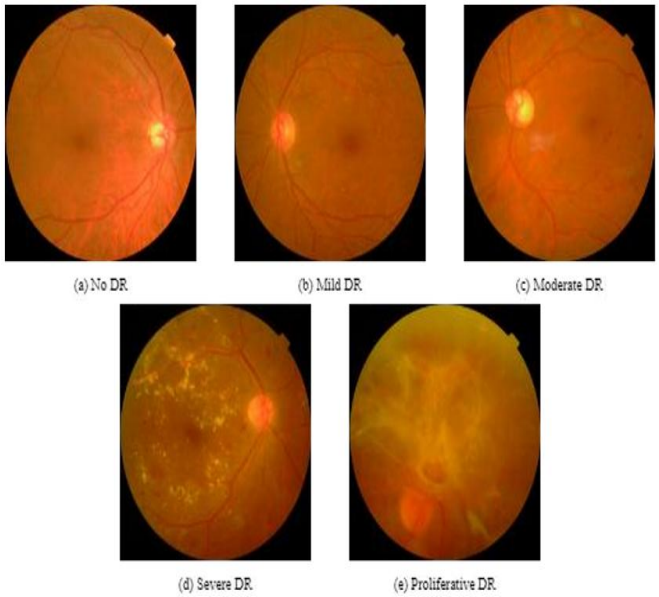

Fig. 2. Stages of Diabetic Retinopathy

II. METHODOLOY

The intended input image is captured by a Fundus Camera, a fundus camera is used to capture the rear view of an eye. Our system provides a graphical user interface in the form of a website for the user to communicate. The input goes through stages as :

A. Preprocessing:-

The input image is acquired from the Diabetic Retinopathy images database. This input image undergoes pre-processing by implementing the following steps:-

1. Resizing images- The input retinal images are resized into small images which makes it easier to avoid overloading and time-consuming
2. Color to Gray conversion- To convert RGB images into Gray images.
3. Filtering- Median Filter a non-linear filter is used to decrease the distortions of an image and suppress noise without blurring sharp edges.

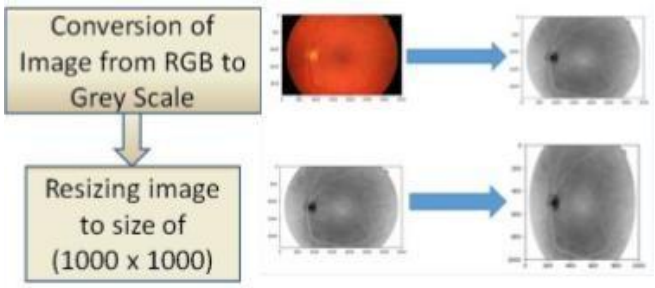

Fig. 3. Pre-processing

B. Feature Extraction:-

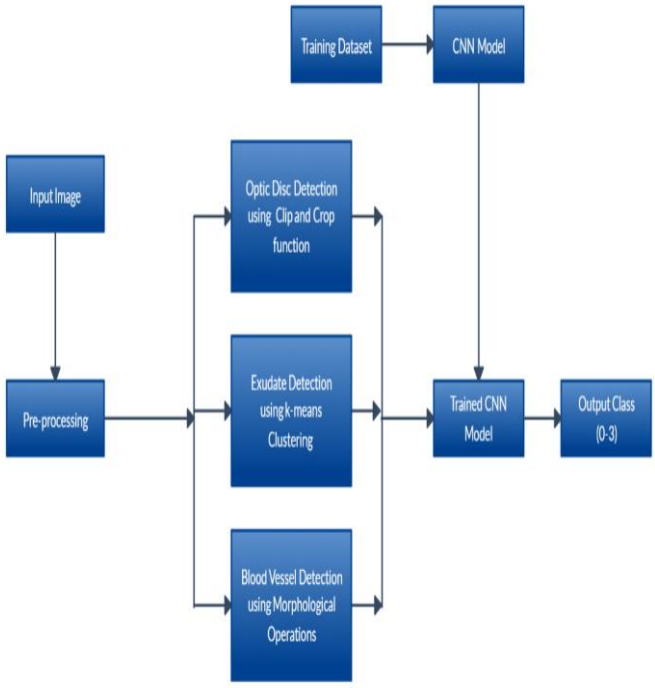

Fig. 4. Design System

The image is classified based on retinal characteristics. The features we have selected are optic disc and cup, exudates, and vessels of the eye. The point of exit for ganglion cell axons leaving the eye is the optic disc. The cup-like white area in the middle of the optic disc is the optic cup. The detection of optic disc and cup is done using the click and crop technique. This technique helps us identify the location of the optic cup and returns its position coordinates.

Fig. 5. Optic Disc Extraction

The optic disc is captured from the image using click and crop technique. This technique creates a rectangular region of interest and helps us obtain the optic disc distinctly. Exudates are small white or yellowish-white deposits of fluid that filters from the circulatory system into the retinal area due to blood vessel damage.

The exudates are identified using the k-means clustering algorithm. The k means algorithm helps to distinguish exudates from the image.

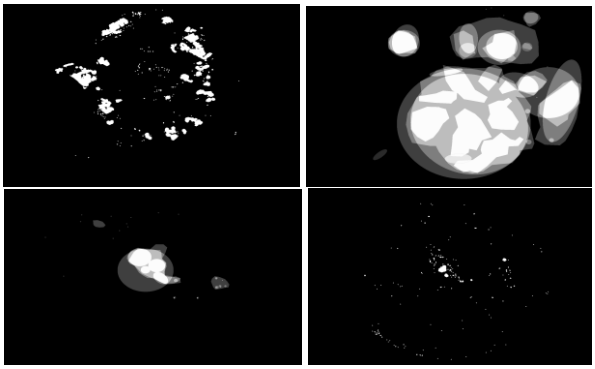

Fig. 6. Exduates Extraction

A retinal vessel appearance is critical in identifying several diseases. Vessel Detection will be done using Histogram Equalization, Thresholding, and Smoothing. Histogram distribution helps identify different patterns and thresholding is the simplest way of segmenting images. The noise amplification issue caused due to histogram equalization is reduced using CLAHE. Smoothing is used to remove noise and obtain a clearer image. The morphological operations like dilate and erode are used to smoothen the image.

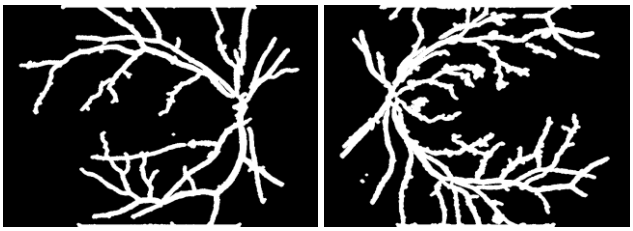

Fig. 7. Blood Vessel Extraction

The classification algorithm which is used to train the model is Convolutional Neural Network. It is different from traditional methods and proven to be effective in image processing and classification. The Trained CNN model classifies the output on a scale of 0 to 3 as-

0- No DR Eye
1- Mild DR Eye
2- Moderate DR Eye
3- Severe DR Eye

No DR is a stage to indicate that the patient does not suffer from Diabetic Retinopathy. Mild DR is a stage when the eye vessel starts developing small balloon-like swelling called micro-aneurysms. In Moderate DR stage, blood vessels nourishing the eye are blocked. In the Severe DR stage, many blood vessels are blocked, critically decreasing the retina blood flow. The diabetic retinopathy until this stage is still non-proliferative. The advanced stage in diabetic retinopathy is proliferative DR damaging the eye severely.

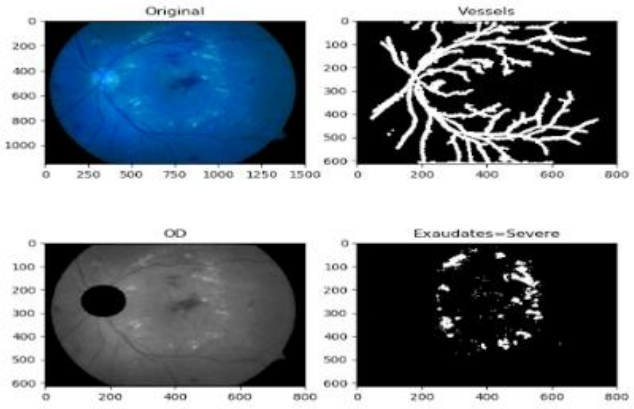

Fig. 8. Output

IV. CONCLUSION

Diabetic retinopathy is an eye complication caused due to diabetes which affects the eye blood vessels and if not treated on time may result in blindness. Hence, early detection of the disease is vital. In this paper, the observations concerning the actuality of Diabetic Retinopathy in a Diabetes mellitus patient is identified using retinal images. These images are obtained from a fundus camera which is used to examine retinal anomalies. We have proposed a neural network-based method for the detection of this condition. The convolutional neural network-based model is a constructive way for image classification. The image processing technique is used to enhance the retinal images and extract the features from them. The acquired attributes are then given to the algorithm for processing. This model predicts the severity of diabetic retinopathy on a scale of 0 to 3. As the scale increases the severity of disease intensifies. The severe stage of the disease increases the possibility of retinal detachment and blindness. Further, actual on the spot capturing of the image and assessing it diabetic retinopathy could be done and increase the classification accuracy to the stage of proliferative diabetic retinopathy.

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