Morphological Process based Segmentation for the Detection of Exudates from the Retinal Images of Diabetic Patients

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***Abstract*--Diabetic Retinopathy is an ocular systemic disease caused by complication of diabetes. It is a major cause of blindness in both middle and advanced age group. Earlier recognition of diabetic retinopathy shields understanding from visual impairment. The heading side effect of this difficulty seeing is the exudates. Exudates are the melted watery grasping solutes, proteins, cells, or cell garbage spilled from the harmed veins into near by tissues or on tissue surfaces in the retina. The spillage of these proteins or lipids causes vision misfortune to the patients. Distinguishing the exudates ahead of time can protect the diabetic patients from difficulty seeing. Ophthalmologists use widening system to identify the exudates. But it causes the irritation to the patients' eyes. This paper focuses on an automated method which detects the diabetic retinopathy through identifying exudates by Morphological process in colour fundus retinal images and then segregates the severity of the lesions. The severity level of the disease was achieved by Cascade Neural Network (CNN) classifier.**

Keywords--Diabetic Retinopathy, Dilation, Erosion, Exudates, Cascade Neural Network.

I. INTRODUCTION

Diabetic retinopathy (DR) is one amongst the foremost serious complications of polygenic disorder and a serious explanation for visual morbidity. It's a progressive sickness classified in line with the presence of assorted clinical variations from the norm. DR is regularly well work the infection is at a late stage, making early location and medication fundamental. Hence, there's partner expanding consideration for settling medicinal frameworks that may screen an oversized mixed bag of people to diagnose the DR early enough for co-partner best medicine. DR is classified into two: (i) Background or Non Proliferative Diabetic Retinopathy and (ii) Proliferative Diabetic Retinopathy. Throughout an express instance of non-proliferative retinopathy, broken retinal vessels releases greasy and protein-based particles termed to as exudates [3]. Intraretinal greasy or hard exudates square measure a reasonable indication of DR and conjointly a principle marker for the presence of retinal oedema. On the off chance that collect inside the focal a piece of the film called macular region, oedema and exudates square measure a genuine description for visual misfortune inside the non proliferative sorts of DR [3][4]. When foundation progressions happen inside the focal layer, the condition is termed as diabetic maculopathy, and vision is in peril. rich of the visual weakness are regularly anticipated if the condition is discovered early enough for optical gadget medication. tragically, as an after effect of visual misfortune is normally a late manifestation of progressed diabetic maculopathy, several patients stay unknown when their sickness is inflicting severe retinal injury. Hence, there's associate pressing would like for mass-screening retinal examination for the first detection and treatment of such diseases. Exudates square measure related to patches of tube injury with outpouring and usually characterised as indiscriminately spaced yellow-white patches of different sizes and shapes. Two type of exudates are hard and soft exudates.

Hard exudate is small white or yellow white patches with sharp margins. Often, they seem waxy, shiny, or lustrous. They're set within the surface layers of the retina, yawning to the retinal vessels. They will be organized as individual dots, convergent patches, sheets, or in rings or crescents close zones of retinal dropsy or teams of microaneurysms. Exudates ar often deposited on retinal veins. On X-ray photography, little dots don't seem to be visible, however larger patches might block choroid coat visible radiation. Soft exudates: In extreme stages of Diabetic Retinopathy, sure spots referred to as the cotton spots are known. The retinal pre capillary arterioles provision blood to the nerve fiber layer are clogged and associatively the native nerve fibre axons get swollen; thereby creating a cotton wool spot.

Here, we have concentrated on police work exudates because the vital issue of DR unwellness. as a result of exudates ar directly associated with retinal lump and visual loss, and that they ar the one most vital retinal lesion detectable in retinal pictures. that the detection and quantification of them can contribute to the mass screening and assessing of DR. The biological vision system is one in all the foremost necessary suggests that of exploration of the planet to humans, activity complicated tasks with nice ease like analysis, interpretation, recognition and pattern classification[8].The ultimate aim in a very sizable amount of image process applications is to extract necessary options from the image data. Some investigations in the past have identified retinal exudates in fundus images based on their gray level [1,2], their high contrast [3,4] or also their color. Because the brightness, contrast and color of exudates vary

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a lot among different patients and, therefore, different photographs, these method would not work in all the images used in clinical environment.

Akara Sopharak et. al. [5] used FCM technique for exudates segmentation and morphological methods for reconstruction. Usher et.al [6] describes the development an automated system to detect abnormalities such as microneurysm, hemorrhages and exudates in color retinal images. They performed contrast enhancement, segmentation to reveal lesions followed by classification of lesions using neural network.K. Ram et. al. [7] proposed clutter rejection method to detect the Microaneurysyms (MAs). This method has two clutter rejection stages in which MAs are discriminated from Non-MA by using similarity computation. Huan Wang et. al.uses the color emphasizes on a Bayesian measurable classifier to characterize every pixel into sore or non-injury classes[8].

J. David Rekha Krishnan et. al[9] proposed thresholding technique to identify the lesions, optic disc and vascular network and neural network classifier was then used to assess the severity level of the disease. Jaykumari et.al [10] discusses the novel technique of intelligent segmentation followed by classification of exudates by using Echo State Neural Network (ESNN). Moving Window is used to obtain the statistical feature of the images, which are fed as input to ESNN.

Watershed segmentation method was used for segmentation of exudates [11], which needs improvement in distinguishing exudates and optic disc from blood vessels. Li Tang et. al. [12] proposed novel splat feature classification method to detect retinal hemorrhages based on extracting features like color, spatial location, interactions with neighboring splats, and shape and texture information. Finally, best possible subset of splat features is selected by wrapper approach.

Doaa Youssef et al [13] proposed a method to detect the exudates using segmentation process. Firstly, the optic disc and blood vessels are eliminated. The Optic Disc is eliminated using Hough Transform. The Blood vessels are detected by applying Edge Detection algorithm. Then the exudates are segmented using Morphological Reconstruction method.Sinthanayothin et al [14] reported the result of an automated detection of Diabetic Retinopathy by Recursive Region Growing techniques on a 10X10 window using selected threshold values. In the pre-processing steps, adaptive, local, contrast enhancement is applied.Abdolhossein Fathi et al [15] represented a new multi-scale vessel enhancement method based on Complex Continuous Wavelet Transform (CCWT) and uses adaptive thresholding for the blood vessel segmentation.

II.METHODOLOGY

The method attempts to detect the exudates consists of the following steps: 1) Image Acquisition. 2) Pre-processing. 3) Detection of Exudates. 4) Feature extraction. 5) Assessment of severity level of exudates.

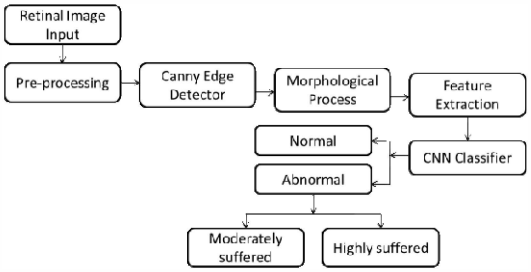


Fig 1. Methodology of Proposed Method

A. Image Acquisition:

The publicly available diabetic retinopathy dataset MESSIDOR has been used in the evaluation process. The MESSIDOR database has been established to facilitate studies on computer-aided diagnosis of DR. The database consists of 1200 eye fundus color images of the posterior pole. The included patients were randomly picked among the diabetic patients from the ophthalmologic departments involved in the MESSIDOR project [14]. An example of an image from the MESSIDOR database is shown in Figure 2.

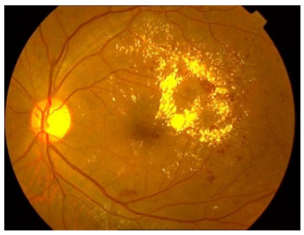
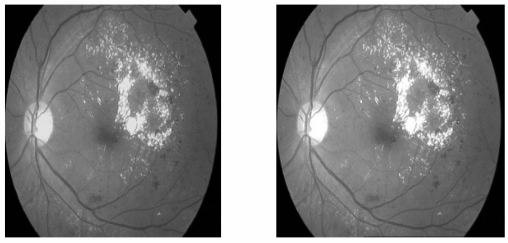


Fig. 2. Image containing exudates

B. Pre-processing:

The input image is applied for pre-processing which involves gray scale conversion, median filtering and histogram equalisation using CLAHE. Gray scale conversion of a digital image is to convert a color image into gray scale picture in which the worth of every pixel is a single sample, that is, the quality of each pixel is a solitary specimen, that is, it conveys singularly force illumination. Pictures of this kind square measure made singularly out of shades of ash, variable from dark at the weakest force to white at the strongest. Ash scale pictures have numerous shades of light black in between. Hence the input retinal color image shown in Figure 1 is converted into the gray scale image as Figure 3(a).The gray scale conversion is preferred here because processing of single sample is easier than processing of three samples (RGB) in colour images.

Then the gray scale image is applied for the noise removal using the median filter. The median filter is used to adjust the contrast intensity and small pixels considered to be noise are removed. After the removal of noise, the resultant image is improved for image enhancement. Because, the contrast of the fundus images tends to be bright in the centre and diminish at the side, hence Histogram Equalization is essential to minimize this effect and have a more uniform image. Here the CLAHE histogram equalisation is used. The contrast improved image shown in Figure 3(b) is then applied for the segmentation process.



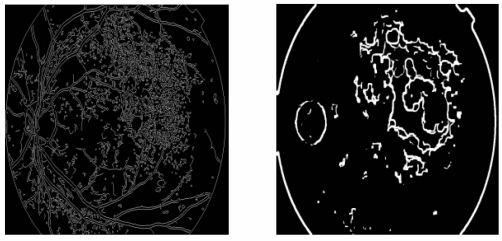
(a) (b)

Fig. 3. (a) Gray scale image. (b) Contrast enhanced image.

B. Recognition of Exudates:

1. Elimination of Optic disc:

The Optic Disc (OD) is the sharpest feature of the normal fundus, and it has approximately a slightly oval (elliptical) shape. In coloured fundus images, the OD appears as a bright yellowish or white region. Exudates have high and similar intensity values of Optic disc. So it is necessary to eliminate the optic disc from the retinal image. This brighter optic disc should be masked and removed. The edge detection algorithm is used for eliminating the optic disc and it is initiative for the elimination of blood vessel segmentation and detection of exudates. Canny edge detector is taken up here which has the algorithm to find the edges where the gray scale intensity of the image changes and this variation can be obtained by determining gradients of the image. It boosts the blurred edges by preserving all local maxima in the gradient image. It can identify the boundaries optimally. The edge detected image is shown in the Fig. 4(a) and the eliminated optic disc image is shown in the Fig. 4(b).



(a) (b)

Fig. 4. (a) Edge detected image (b) Optic disc eliminated image.

2. Blood vessel segmentation:

Now the optic disc is eliminated, then to remove the high contrast blood vessel the morphological process is performed. Because the blood vessels are having somewhat similar contrast as the blood vessel. Dilation operator on the intensity image will help to eliminate the high contrast vessels. Dilation is a morphological operator which can expand the blood vessels by potentially filling in small holes (structuring element) and connecting disjoint pixels. It can be performed by laying structuring element (SE) on that image and sliding over the image. Structuring element, which describes flat disc shaped structure, is used with the aim of removing the vessels that remain in the optic disc region. If the SE starts from brighter pixel, there will be no change. It will move to next pixel. If the SE starts from dark pixel, make all the pixels black from the image covered by the SE. The disc shaped SE (B) is applied on the image A, then the dilated image obeys the following equation 1.

$$A \oplus B = \{Z \mid (B)_z \cap A \neq \square\} \quad (1)$$

After applying the equation 1, the edge detected image gets dilated which is shown in Fig. 5(a). Erosion operator is used to minimize objects by etching their boundaries without affecting other portions by satisfying the equation 2.

$$A \Theta B = \{Z \mid (B)_z \subseteq A\} \quad (2)$$

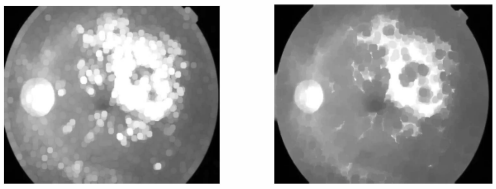
The erosion operator will be used on the dilated image to completely remove the blood vessel from the retinal image which is shown in Fig. 5(b).

3. Exudates Identification:

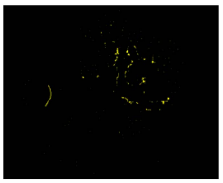
After removing the optic disc and blood vessels from an image, exudates can be detected by closing operator. Image closing operator will be performed on the eroded image since dilation is followed by erosion. It can distinguish the exudates portion from the non-exudates pixels. The closing of an image A by structuring element B is defined as the equation 3.

$$A \bullet B = (A \oplus B) \Theta B \quad (3)$$

The resultant image, shown in Fig. 5(c) was exposed in yellowish colour which clearly indicates the exudates pixels in the segmented retinal image.



(a) (b)



(c)

Fig. 5. (a) Dilated image. (b) Eroded image. (c) Exudates detected image.

C. Exudates Severity level Assessment:

In order to assess the severity of the exudates, a special classifier called the Cascade correlation Neural Network Classifier is used. The neural network classifier is fed the features of the image having the presence of exudates. The features of the input image are extracted by means of GLCM feature extraction. Gray Level Co-occurrence Matrix (GLCM). It contains information about the positions of pixels having similar gray level values. It can make use of distance vector. The gray-level co-occurrence matrix is represented as G[i,j] which is used to calculate all pair of pixels separated by distance vector having gray levels i and j. Based on the analyzed matrix and the texture information, the following features like entropy, contrast, correlation, energy, homogeneity and dissimilarity were obtained.

This feature selection process can also reduce noise and enhance the classification accuracy. Then the extracted features are given to the CNN classifier to assess the severity level. Cascade Neural network is a new design and supervised learning algorithmic rule for Artificial Neural Networks. rather than simply adjusting the weights during a network of mounted topology, Cascade-Correlation begins with a token network, then mechanically trains and includes new shrouded units one by one, making a multi-layer structure. When a fresh out of the box new shrouded unit has been extra to the system, its enter-side weights square measure solidified. much the same as the methods, the algorithmic principle takes after: one. CC begins with a token system comprising singularly of co-partner degree data cohort degreed a yield layer. each one layers square measure totally joined. 2. Prepare all the associations finishing at co-partner degree yield unit with a standard taking in algorithmic principle work the lapse of internet now not diminishes. 3. Create the charged hopeful units. Every competitor unit is associated with all data units and with all current shrouded units. In between the pool of hopeful units and in this manner the yield units there aren't any weights. 4. Endeavour to boost the correspondence between the enactment of the hopeful units and subsequently the lingering mistake of internet by guiding all the connections bringing about a competitor unit. Taking in happens with a standard taking in algorithmic principle. The drilling is halted once the relationship scores now not moves forward. 5. Choose the competitor unit with the most association stop its approaching weights and add it to internet. 6. To shift the competitor unit into a concealed unit, produce interfaces between the picked unit and each one the yield units. Since the weights bringing about the new concealed unit square measure solidified, a shiny new changeless characteristic finder is acquired. Circle over to step a pair of. 7. This algorithmic rule is continual till the general error of world wide web falls below a given price. This is provided in the Fig. 6.

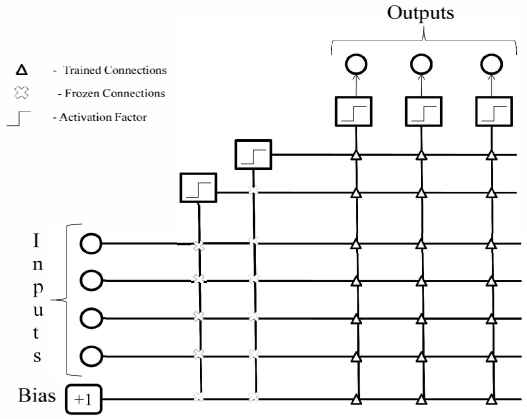


Fig. 6. Architecture of CNN classifier.

Thus the way the classifier gives the severity level of the exudates which will help ophthalmologists to predict the stages of diabetic retinopathy affected by a patient.

III. CONCLUSION

Diabetic retinopathy eye sicknesses are the fundamental driver of vision misfortune and their predominance is situated to keep climbing. Current routines for location and evaluation of diabetic retinopathy are manual, unreasonable and require prepared ophthalmologists. Programmed Diabetic retinopathy eye ailments recognition might be useful for diabetic retinopathy screening Process. Early recognition can possibly diminish the danger of difficulty seeing. A programmed system to discover Diabetic retinopathy eye maladies utilizing Morphological methodology is proposed. There are two modules in this work, one that performs picture division which incorporates the division of optic circle, veins and exudates and other one that performs order utilizing Cascade Neural Network classifier. Preprocessing with complexity improvement is connected before three characteristics, to be specific optic plate, veins and exudates are concentrated to supply as info parameters to coarse segmentation using Morphological process.

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