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Image Processing and Data Mining Techniques in the Detection of Diabetic Retinopathy in Fundus Images

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ABSTRACT

Diabetic Retinopathy is a most common retinal disease which affects diabetic patient's eyes with high rate of diabetes which causes blindness. It is a disease in which retinal vessels started leaking fluid and blood through vessels and makes vessel swell. If patients diabetic rate goes high this disease can cause permanent blindness. Early detection of this disease can be done by using automatic Screening. By using Image Processing and Data Mining technique Automatic screening can be possible and that will be easier for doctor's review and patient's early treatment.

Keywords: Diabetic Retinopathy, Sobel Edge Extraction, Decision Tree Ellipse Fitting ,

1. INTRODUCTION

Diabetes is a well known disease which may cause defect in the retina (diabetic retinopathy) and is also known to be a major risk for many Heart related diseases. Diabetic retinopathy is a micro vessel complication caused by diabetes which can lead to blindness. When rate of diabetes increases it may walk towards permanent blindness. Diabetes interferes with the body's ability to use and store sugar (glucose). The disease is characterized by too much sugar in the blood, which can cause damage throughout the body, including the eyes. In early stages of diabetic retinopathy typically there are no visible signs but the number and severity of defects increase during the lifetime. Diabetic retinopathy initiates with small typical changes in retinal capillaries. The first observable abnormalities are micro aneurysms which represent abnormal growth of the retinal capillaries. After a period of time, hard exudates may appear. The lipid formations due to leaking from weakened blood vessel leads to hard exudates. Symptoms of diabetic retinopathy include:

- Spotted vision
- Blurred vision
- Having a dark or empty spot in the center of your Vision
- Difficulty seeing well at night

People with diabetes experiencing symptoms like high blood sugar, fluid leaking inside the lens which change the curvature of the lens, and that causes blurred images. This blurred vision distance will improve when blood sugar levels are controlled,. Patients with diabetes who can better control their blood sugar levels will slow the onset and progression of diabetic retinopathy [1]. There are two main types of diabetic retinopathy 1. Non-proliferative diabetic retinopathy (NPDR) 2. Proliferative diabetic retinopathy (PDR) Early stage of diabetic Retinopathy is Non-proliferative diabetic retinopathy (NPDR) symptoms in this

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disease are mild or non-existent. While in NPDR, the blood vessels in the retina are weak which cause tiny clots called microanuerysms. PDR (Proliferative diabetic retinopathy) is harmful and next stage of Diabetic Retinopathy. At this stage of PDR, new harmful blood vessels can begin to grow in the retina and the vitreous, the white gel like fluid that fills the back of the eye [1]. Blood is started flowing through the newly form blood vessel into the vitreous of eye which gives the blurring vision. Diabetic retinopathy from the damage of retina due to the small blood vessels located in the retina which is responsible for vision loss.

- Fluid can leak into the macula, the area of the retina responsible for clear central vision. Although small, the macula is the part of the retina that allows us to see colours and fine detail. Macula is a part of retina which is responsible for the fine colour details. The fluid causes the macula to swell, resulting in blurred vision [1].
- In an attempt to improve blood circulation in the retina, new blood vessels may form on its surface [1].

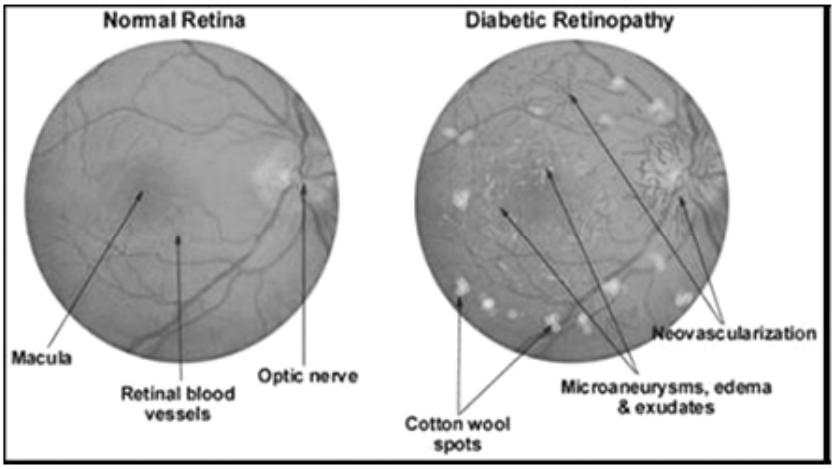

Figure: 1 Structure of Normal and Diabetic Retina

Treatment of diabetic retinopathy varies depending on the extent of the disease. People with diabetic retinopathy may need laser surgery to seal leaking blood vessels or to discourage other blood vessels from leaking. Your optometrist might need to inject medications into the eye to decrease inflammation or stop the formation of new blood vessels. People with cases of PDA might be use surgical procedure to remove or replace the gel-like fluid which forms cloudy image, called the vitreous. Surgery may also be needed to repair a retinal detachment. Light-receiving lining which is present in the backside of the eye forms the separation. In this paper, we have implemented an application using image processing technique that is Sobel operator, ellipse fitting, KNearest Neighbour, histogram thresholding and Classification using data mining technique that is Decision tree algorithm for automatic detection of Diabetic Retinopathy using retinal images.

2. LITERATURE REVIEW

In literature of diabetic retinopathy earlier study highlighted Automatic Detection of Diabetic Retinopathy using Image Processing and Data Mining Techniques which Reduce cost and time at great extent [1]. The study also includes Automatic Exudates Detection from Non-dilated Diabetic Retinopathy-Retinal Images Using Fuzzy C-means Clustering in Which the low contrast retinal image-intensity increased and a number of edge pixels were extracted but it consumes more time [2]. In study of a contribution of image processing to the diagnosis of diabetic retinopathy the, detection of exudates in colour fundus images of the human retina time consumption is reduced as it uses mathematical morphology techniques while it decrease sensitivity [3]. Using Contrast Limited

Adaptive Histogram Equalization Extraction of Retinal Blood Vessels from Diabetic Retinopathy Imagery performed successfully in lack of reduced contrast enhancement on 1 image by divide and conquer rule which removes the limitation of previous study by increasing sensitivity [4]. By using automated screening system for diabetic retinopathy increases sensitivity and predictivity but decreases sensitivity [5].

3. PROPOSED SYSTEM

The architecture of proposed system is depicted in Fig 1. A. Input Image: The images are taken by publicly available Diabetic Retinopathy images database which are captured by Topcon Camera. B. Pre-Processing: Pre-processing is done before segmentation of image which includes Resizing of Image, RGB to Grey scale conversion and Filtering method as given in following figure Fig.2 C. Feature Relevance Analysis:

i. Sobel Edge Extraction: Sobel edge Extraction is use for Detection of optic disc and cup. Optic Disc is reddish yellow in colour and it is more pronounced on the temporal side. It is round to oval in size and its diameter ranges from: 1.5mm to 1. 7mm. It margins have a sharp characteristic. The vessels in optic disc originate from the perimeter and both veins and arteries appear distinct. The size of optic disc may vary from patient to patient and its diameter lies between 40 and 60 pixels in 640x480 colour photographs [1].

between two regions is known as Edges. An Sobel edge detector finds out regions in an image where the Grey levels based on gradient variation. Gradient are changing directional colour quickly to be

a random effect. Sobel Edge Detection systems are very useful because of its low cost and ease of use Compared to other edge operator. Advantages of Sobel Edge Extraction: Sobel provides

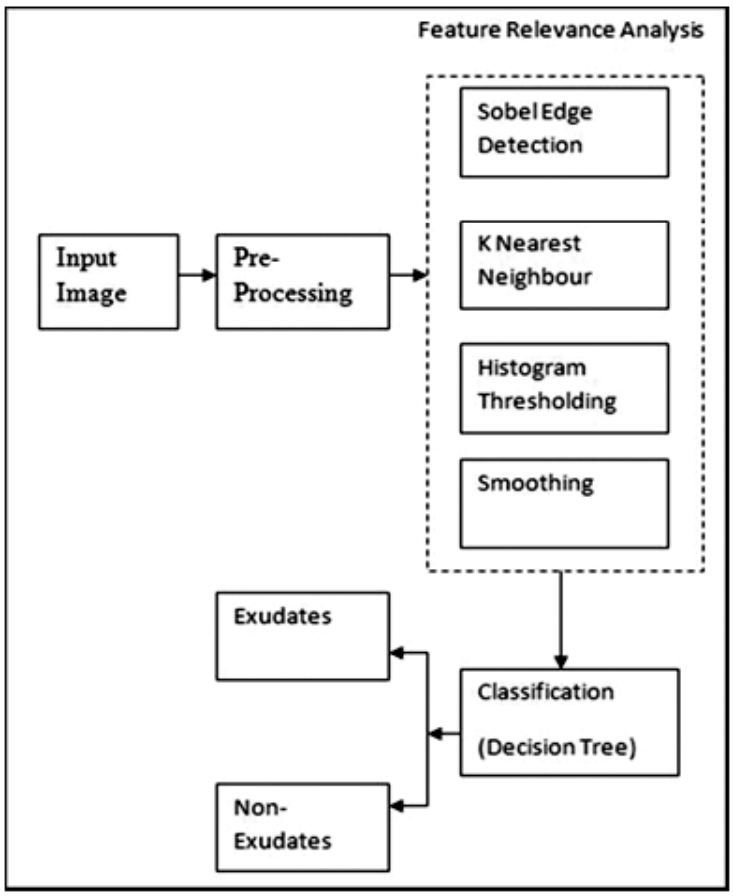

Figure 2: Proposed System

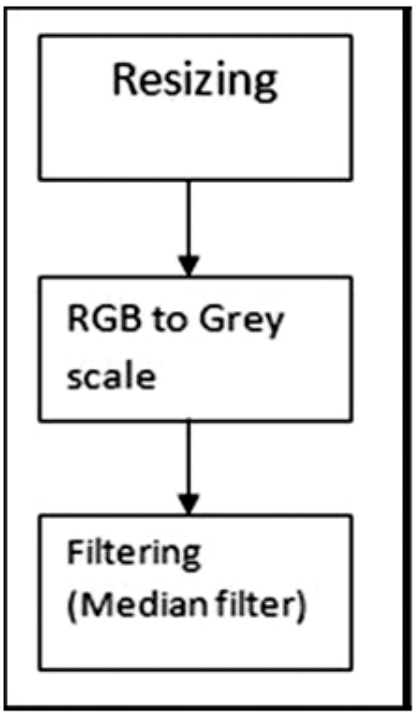

Figure 3: Pre-Processing

smoothing effect to the random noise of image because of average factor introduction. [1] The edge seems bright and thick as it contains two rows or columns.[1] Sobel operator is an orthogonal

gradient. Gradient corresponds to first derivative. For a continuous function Fl (x, y), in the position Pl(x, y), its gradient can be expressed as a vector (the two components are two first derivatives

which are along the X and Y direction respectively.

$$F(x, y) = [Gx\ Gy]T = [\delta f/\delta x\ \delta f/\delta y] \quad (1)$$

Where Gx is for x Direction and Gy is for y Direction Sobel (3*3) Mask for X direction is:

–1	–2	–3
0	0	0
1	2	3

Sobel (3*3) Mask for Y Direction is:

–1	0	1
–2	0	2
–1	0	2

Gx and Gv are the first derivative operators at any point which are defined as

$$Gx = [f(x+1, y-1)+2\ f(x+1, y)+ f(x+1, y+1)]-[\ f(x-1, y-1)+2\ f(x-1, y)+ f(x-1, y+1)] \text{ And}$$

$$Gv = [\ f(x+1, y-l)\ )+2\ f(x, y+1)+ f(x+1, y+1)]-[\ f(x-1, y- +2\ f(x, y-1)+ f(x-1, y+1)]$$

Where f is the mask value In given system the conversion of colour retinal images into grey level image is done to extract the edges before the fast Sobel edge filter. This filtering Process produces a binary image. After filtering represents edges are represented by the positive data and unknown texture is represented by the negative data. The edges may be the outline of optic Disc, cup and blood vessel.

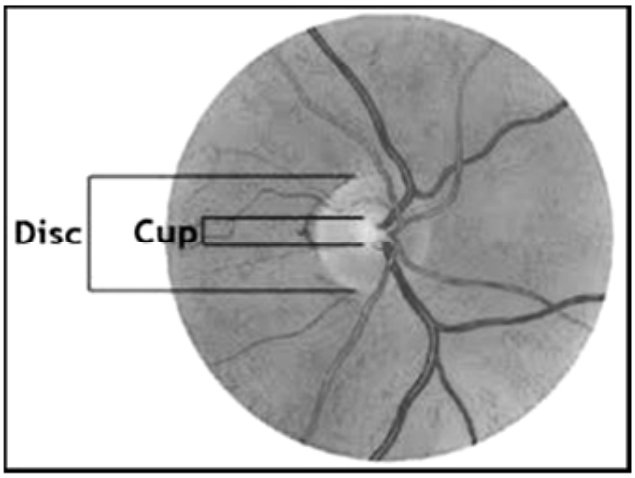

Figure 4: Optic disc and cup detection.

a. Curve Fitting Approach: Optic disc requires range of ellipses as the shape of a normal optic disc varies from round to oval. This tries to appropriate size into edges extracted as given in Fig. 5. Finding

b. the best fitting model with less number of parameters is very challenging task [1].

ii. KNN Classification (K-Nearest Neighbour):

The image is divided when processes like Histogram; smoothing and edge detection is carried out on retinal images. KNN is used for classification of each pixel with its value to determine whether pixel is vessel or not. The algorithm can be given as:

1. A positive integer j' and a new sample is taken
2. Select the j' entries which are closer to the new sample.
3. Finding most common classification of these entries.

This classification is given to a new sample.

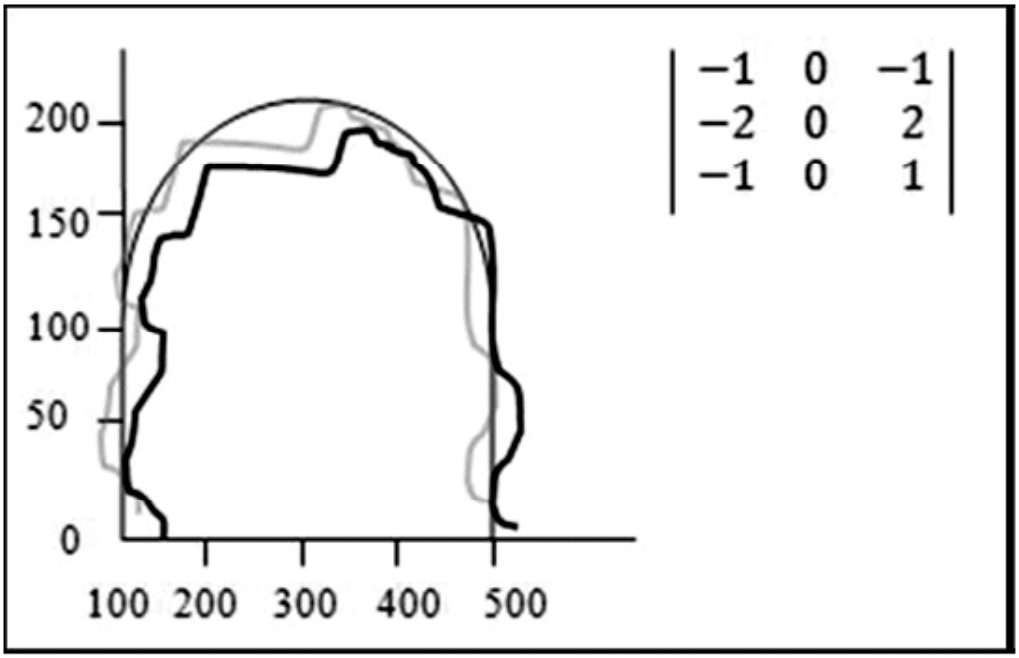

Figure 5: Curve Fitting.

Vessel appearance is an important factor for various diseases [1]. Vessels are large in size and straight with smooth curves. The average diameter of veins is 125).lm. There are many vessel Detection methods which are useful in finding the vessels related diseases. Vessel detection can be done by following methods:

a. Histogram Thresholding: Histogram distribution plays an important role in the detection of optic cup by histogram distribution of the optic disc region which reveals an interesting pattern. Thresholding method is use for converting gray scale image into binary image by segmenting them. An important parameter in the process of thresholding is the choice of threshold value [1]. The threshold operation defined as:

$$G(x, y) = \{Go \text{ if } f(x, y) > T \; Gb \text{ if } f(x, y) \leq T \quad (2)$$

Where, f(x, y) is the original image and g(x, y) is the threshold processed image. T is the threshold value, Go is the object gray level value after thresholding operation and Gb is the background gray level value after thresholding operation [1].

Less pixel value results in noise reduction of an image. Smoothing is mainly use for the noise reduction due to its reducing pixel values property. The data points of a image are changed because of that individual points values changes, and points that are having lower value than neighbour values are increased leading to a smoother image Basic idea behind smoothing is slow changes of value with little attention given to the accurate matching of data values, while curve fitting emphasizes on achieving a accurate match as possible [1].

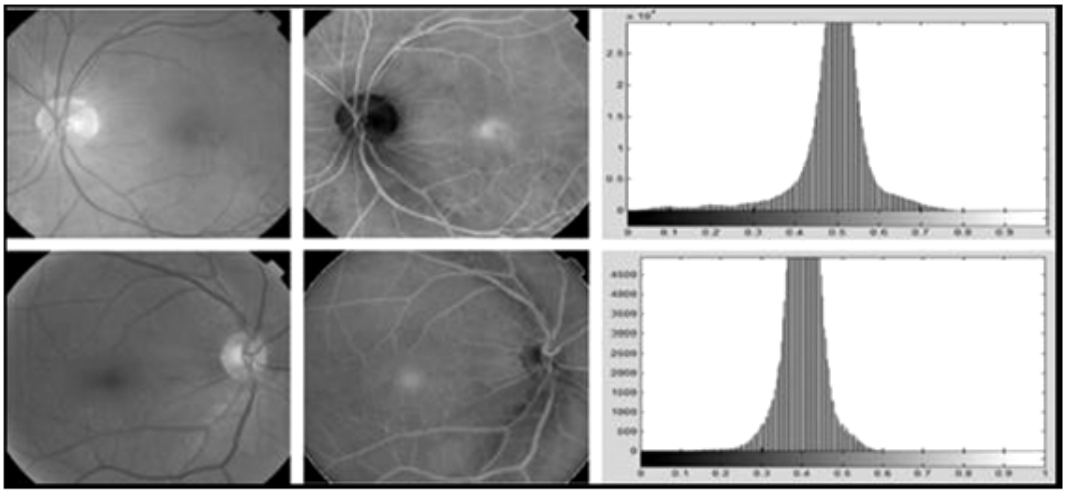

Figure 6: Histogram

3.1. Classification Using Data Mining

Decision Tree: A decision tree is a tree like decision support model. It is also known as model of decisions, which includes chance event outcomes, resource cost and utilities. When a particular group has to take a decision, decision tree plays an important role by focusing on decisions. Decision tree is used in data mining to simplify complex methods and calculate the cost effectiveness business decisions and research [1].

Algorithm

The steps in decision tree algorithm are as follows:

Step 1: Consider attribute and divide the possibilities, consider it as decision node.

Step 2: Repeat this process again for each child Stop when:

i. Results same attribute value for all possibilities

ii. No more attributes.

iii. No more possibilities.

4. RESULTS

Results for Diabetic Retinopathy are as followes :

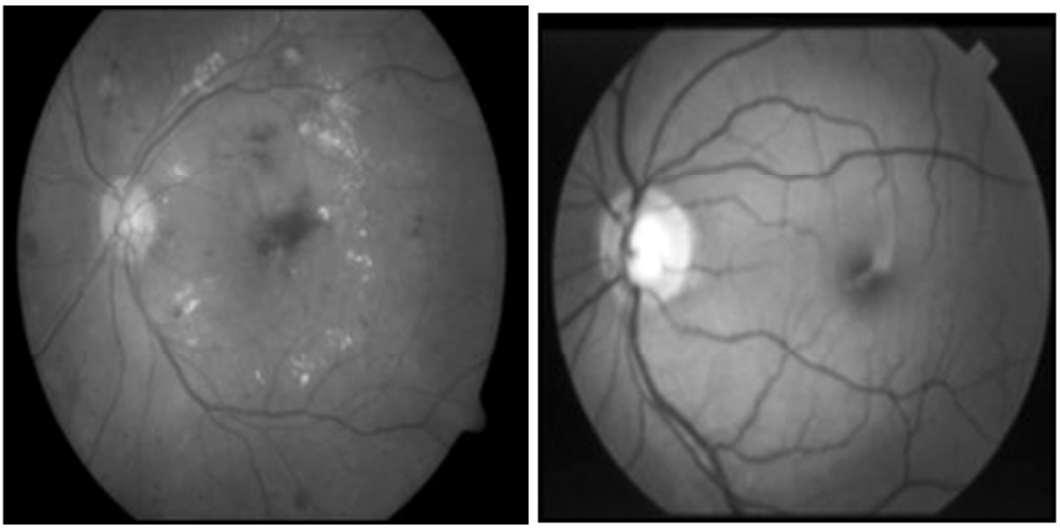

Figure 7: Image one input a) Original Retinal Image b) Grey Retinal Image

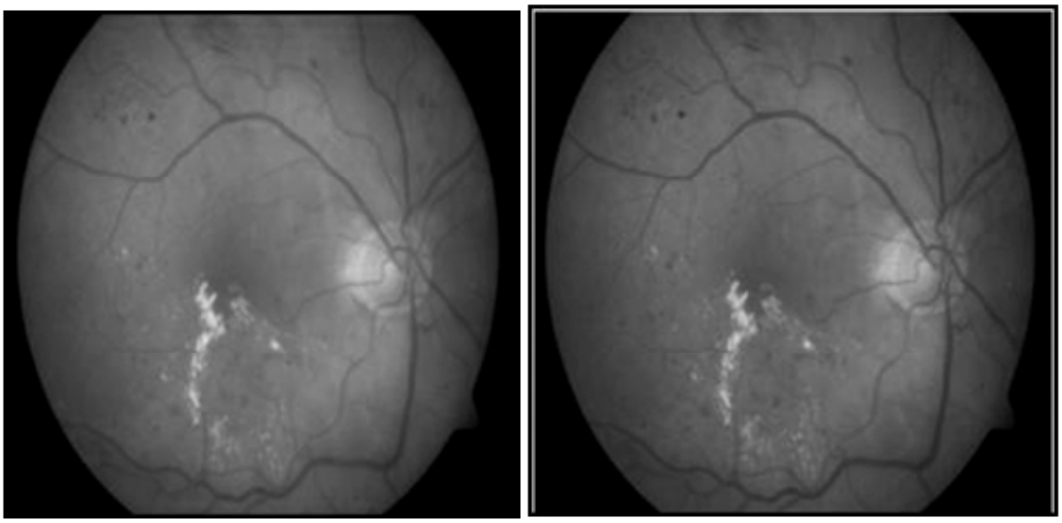

Figure 8: Image two input a) Original Retinal Image b) Grey Retinal Image

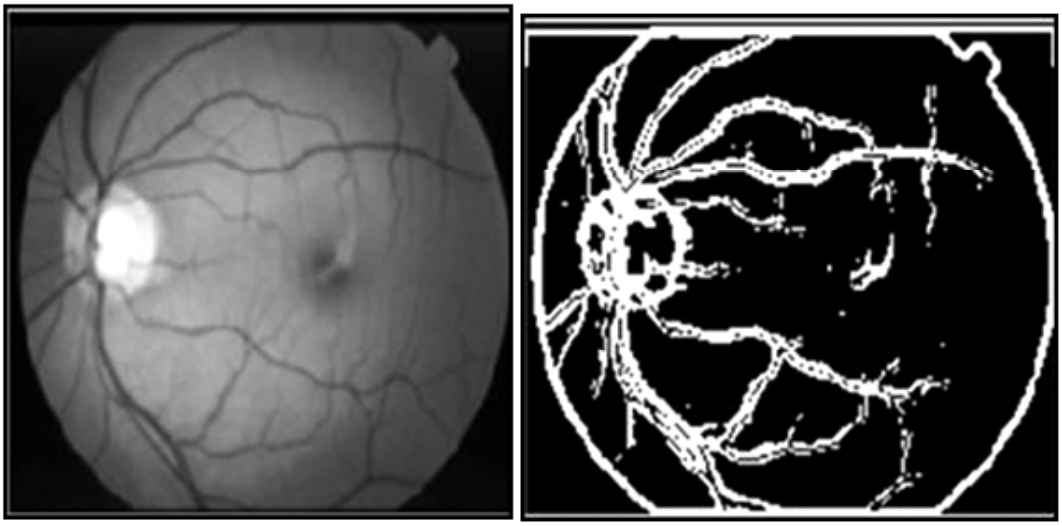

Figure 9: Image one Output a) Grey Image b) using Sobel operator

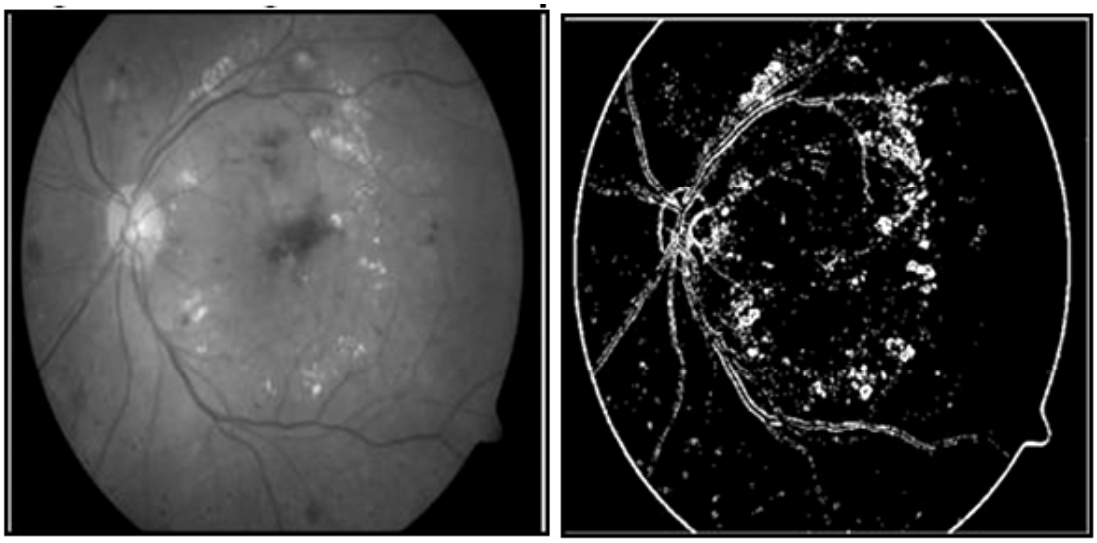

Figure 10: Image two Output a) Grey Image b) using Sobel operator

5. CONCLUSION

In this paper, the selected features are classified into exudates and non exudates using KNN Classification and Sobel Operator for Edge Detection Using this approach, the exudates are detected. The data mining technique like Decision Tree Algorithm accurately categorize the disease associated with the retina based on the features extracted from retinal images through image processing techniques.

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