

# Automatic Detection of Exudates in Retinal Images using Saliency Map Method

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## Abstract:

Exudates are in the form of a fluid that has leaked out of blood vessels and closely resembles blood plasma. It is a major complication of causing blindness in Diabetic Retinopathy (DR) patients. The main objective of this study is to develop a novel method to finding the exudates with high accuracy and classify exactly what are mild and severe exudates based on color indication with complete and distinguished patient information in color retinal images by using a saliency map algorithm. The Proposed approach starts with a normalization of retinal image, contrast enhancement, noise removal, and the localization of Optical Disc (OD). Then, a segmentation method by using Saliency map to detect only exudates regions. Finally, classification using the support vector machine (SVM) is applied to detect what type of exudated retinal image based on color indication with patient information. Based on a comparison between the results and ground truth images, the proposed method obtained an accuracy for detecting exudates as 98.50%, 98.35% and 98.15% respectively.

**Keywords – Retinal images, Exudates, Saliency map, Support vector machine (SVM), Optical Disc (OD).**

## I. INTRODUCTION

Exudates are bright lipids leaked from a blood vessel. In retinal images, exudates exhibits as a chromatic localized regions with variable sizes, shapes and locations. [1]. Current strategies of exudates detection take longer time and to identify only exudates. However, identifying the small exudates remains inadequate. In doing therefore the patients won't receive proper treatment as early as possible. [2]. Several examples of the methods for exudates detection in retinal images are often found within the literature. Few investigation within the past have detected exudates using Fuzzy C-means clustering (FCM) and thresholding algorithms applied to detect the exudates. [3]. The abovementioned methods have certain limitations in detecting small exudates regions. Hence the proposed approach of exudates detection easily Identify the small and mild exudates with proper color indication. [4]. We Investigate a new method towards identifying the small, mild, severe exudates with proper color indication. The most contributions of the new methods are twofold:

- 1) The main objective of this propose method is develop a study for type of exudates detection with proper color indication and displaying the patient information in color retinal images by using Saliency map algorithm. This might benefit the retinopathy patients, as their treatment are getting to be more adequately and functionally. [5].
- 2) Finally, the support vector machine (SVM) algorithm is used to classify what kind of exudates based in exudated image with color indication. Figure (1) shows an example of exudates.



A) Original image

B) Exudated image

Figure 1: Normal and abnormal retinal image

## II. PROPOSED MODEL

The proposed method are constructed to solve the problem of exudates using Saliency map method, which is presented and evaluated on two different databases. The Saliency map is proposed for segmentation of retinal images. It can separate exudates lesions and background parts of the retinal image with great information. Saliency map is an grayscale image during which the brightness of an pixel is directly proportional to its saliency. It is used in medical imaging, and various visual models. Exudates in retinal images generally have a brighter intensity than background. Finally, Based on the types of exudates it will indicate a color using support vector machine (SVM). The representation of an retinal image in RGB color space allows to studying separately the various channels of the spectral response. The three colors are (red, green, blue) each of which has intensity value starting from 0 and 255.

The extended work to detect and recognise the exudates and their regions within the retinal images with high accuracy and that we created a framework to classify exactly what are mild and severe exudates with complete and distinguished patient information. We indicate a color supported the type of exudates presented within the retinal image.

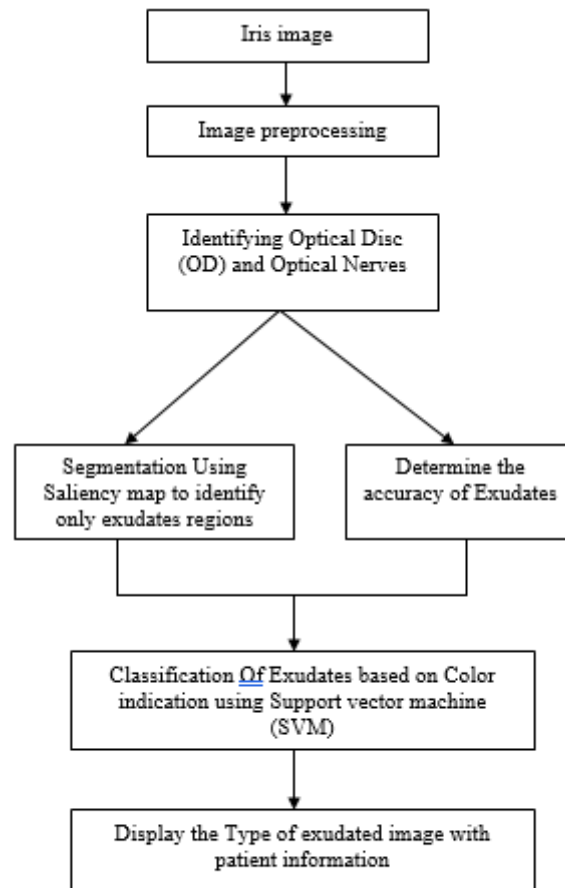


Figure 2: Overall procedure for exudates detection using Saliency map.

The schematic diagram of the proposed method is illustrated in figure(2).

The steps to follow the proposed method are:

- Pre-processing
- Identifying Of Optical disc (OD) and Optical Nerves.
- Exudates Detection Using Saliency map.
- Classifying of Exudates based on color indication using Support vector Machine (SVM).

#### A. Pre-Processing

The images are taken from Retina centre with patient information and high resolution cameras. Pre-processing is necessary for original retinal images. The Illumination correction is required to normalize the image, contrast enhancement, noise removal and localization of Optical disc (OD) before starting the segmentation stage.

Retinal image is an RGB color image, in general RGB images consist of three channels (Red, Green, Blue). The blue channel is characterized by low contrast and does not contain much information. The vessels are visible in Red channel but this channel contains too much noise .while the green channel will give the best results in the contrast of blood vessels.

#### B. Identifying of Optical disc (OD) and Optical Nerves:

Optical disc is determination of the center of optical disc which is the lighter and brightest part of retinal image. The localization of Optical disc, will be achieved by compute red channel (R) and green channel (G) from the original RGB color retinal image then to compute the ratio between red and green channel (R/G) to obtain all the light and bright regions in the image.

For each pixel we calculate (D), where

$$D = R/G$$

Optical nerves is determination of proper nerves should be connected with the optical disc. The nerves are useful for finding any leakage in the blood vessel. Figure (3) is the Example of Optical disc and Optical nerves.

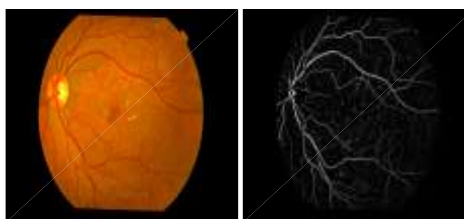


Figure 3: Optical Disc and Optical nerves.

**C. Exudates Detection Using Saliency map:**

To segment the Exudates region using the saliency method to determine a threshold value to acquire the final segmentation. Saliency method could capture the unique colors in the image. The Saliency map *Smap* of image *I* which has a length of *W* and width of *H* pixels formulated as

$$Smap(x,y) = \|I\mu - Iwhc(x,y)\|$$

Where *Iμ* is the mean pixel value of the image and *Iwhc* is a Gaussian blurred vector version of the original image to remove unwanted noise and  $\| \cdot \|$  is the norm. The detection of exudates using saliency map is illustrated in figure (4).



Figure 4: Saliency map using detection of exudates

The overall value of accurate exudates segmentations is derived from the “Accuracy” value, which is calculated by Accuracy = TP+TN/TP+FP+FN+TN

$$Accuracy = \frac{TP+TN}{TP+FP+FN+TN} * 100$$

True Positive value (TP), False Positive value (FP), False Negative value (FN), and True Negative value (TN). TP refers to the accurate segmented number of exudates pixels. FP refers to the non-exudates pixels that are inaccurately segmented as exudates pixels. FN refers to the number of exudates which are not segmented. TN refers to the non-exudates pixels which are accurately segmented as non-exudates.

**D. Classifying of Exudates based on color indication using Support vector Machine (SVM):**

Support vector machine method is used for classification of what type of exudate retinal image. 50 images were provided as training data along with the labels. If the retinal image is normal image, then there is no need of segmentation. If the retinal image is abnormal, then the exudates is finding by using the support vector machine (SVM). Here we indicate a color based on the type of exudates:

- For Tiny Exudates: Red color indicated.
- Mild Exudates: Blue color indicated.
- Severe Exudates: yellow color indicated.

Therefore based on the color indication and percentage of exudates the patient will get the faster treatment and it will prevent the blindness of retinopathy patients.

Support vector machines are classifiers makes use of color information to perform the classification of retinal exudates. Figure (5) Illustrates the mild and severe exudates.

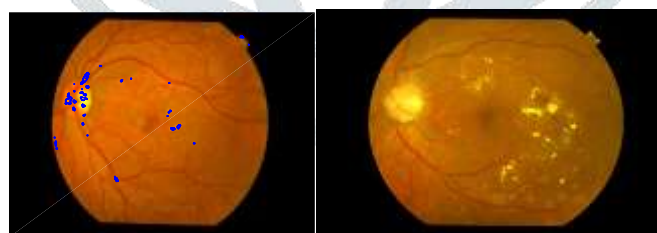


Figure 5: Mild and Severe Exudates based on color.

**III.RESULTS**

In this approach we got more accurate outputs by Using MATLAB version R2016. Figure 6,7 represents the exudated retinal image, identifying of optical disc (OD), and Segmentation of optical disc. Here we identify the RGB channels for detecting the optical disc. Figure 8 represents the pseudo color processing of retinal image for increasing the contrast enhancement, noise removal and optical disc.

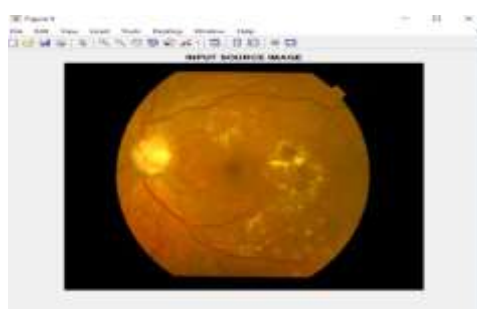


Figure 6: Test Exudated Retinal image

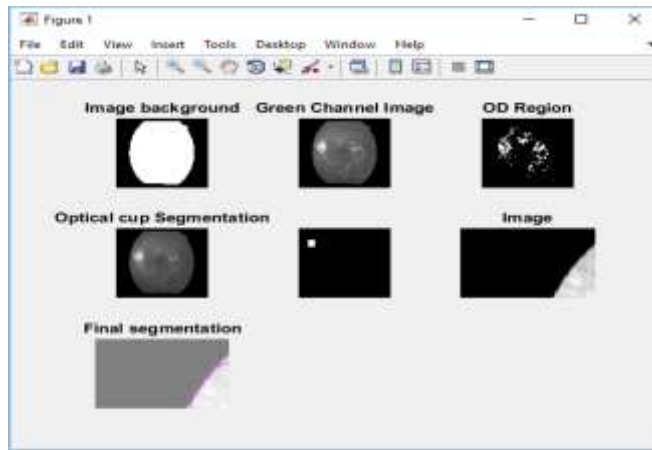


Figure 7: Pre-processing of test retinal image, optical disc detection, optical cup segmentation.

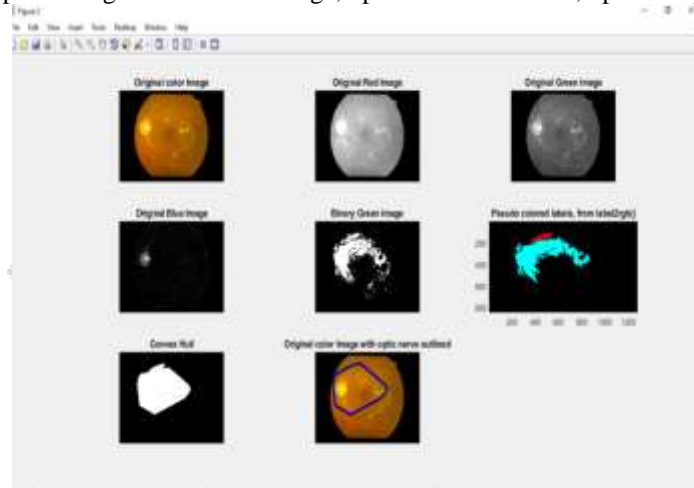


Figure 8: Pseudo color processing of the individual color subspaces with optic outline.

Figure 9 indicates optical nerves and optical disc to detect any leakage of blood vessel around the plasma. Figure 10 shows that detection of exudates only by using the saliency map estimation. Here we identifying only the exudated regions. Figure 11,12 indicates the what type of color exudates presented in the retina and displays the description about patient by using the support vector machine (SVM). Figure 13 indicates the accuracy of detecting the exudates.

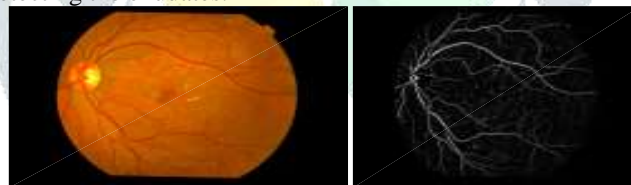


Figure 9: Retinal vein pattern extraction and analysis.

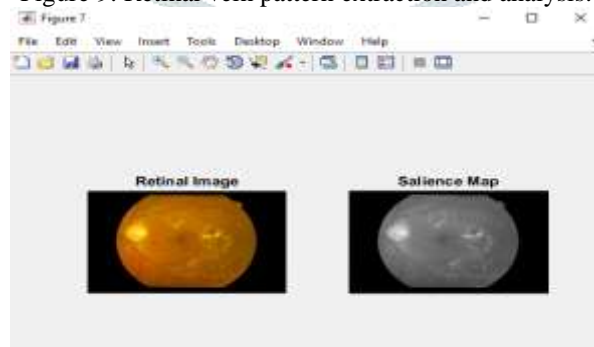


Figure 10: Saliency map estimation.

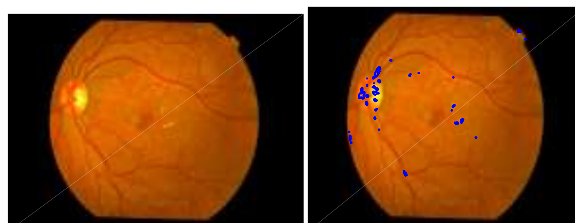


Figure 11: Identifying the exudates based on color Indication.

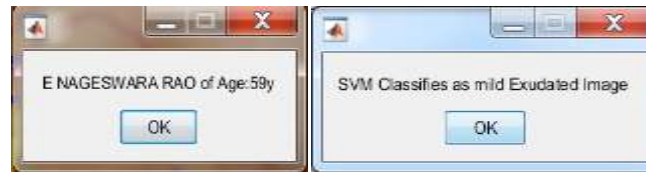


Figure 12: Patient information and Type Of Exudates Based On color.

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Command Window
New to MATLAB? See resources for Getting Started.
> In svmclassify (line 122)
  In svm (line 6)
  In MAIN1 (line 308)
  Y SYAMALA of Age:60y
  SVM Classifies as severe Exudated Image
  Accuracy of exudate detection:98.760000
fx >>

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Figure 13: Accuracy of exudates.

#### IV. CONCLUSIONS

The present paper discusses to detect a exudates by employing composite features based on saliency map algorithm. The results of the current study have proved success in detecting the even at different stages like heavy, mild and tiny exudates regions with specific color identification and increases the accuracy values which are 98.50% of exudates detection using Saliency detection method. Therefore, the saliency map algorithm can be used to evaluate the color retinal images for exudates detection without requirements of experts.

#### V. REFERENCES

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