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# DETECTON OF EXUDATES IN RETINAL IMAGES USING LINEAR SPATIAL FILTERING

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***Abstract***— — This Research presents a method to detect the exudates in retinal image by using mathematical morphology and spatial relationship in pixels. Diabetic retinopathy is a common disease among diabetes which causes poor vision. The retina is a thin layer of light-sensitive tissue that lines the back of the eye. Light rays are focused on to the retina where they are transmitted to the brain and interpreted as the image you see. The macula is a very small area at the center of the retina .It is the macula that is responsible for your pinpoint vision, allowing you to read, see or recognize a face. The surrounding part of the retina called the peripheral retina is responsible for your side or peripheral vision. Diabetic retinopathy usually affects both eyes people who have diabetic retinopathy often don't notice changes in their vision in the disease's early stage. But as it progresses, diabetic retinopathy usually causes vision loss that in many cases cannot be reversed. This Research provides a method for detecting and segmenting the exudates in retinal images. Exudate is a type of non-proliferative retinopathy. It can be detected by applying morphological operation to the retinal images. Finally Grey-level Co-Occurrence Matrix have been used to plot the graph and to identify whether the retina to be normal or abnormal.

**Keywords –** *psycholoigcla stress, population, social networks*

## I INTRODUCTION

Diabetes is a common disease, in which the pancreas do not secrete proper amount of insulin in the body. Insulin is important for controlling the blood sugar level, thus humans affected with diabetes have high blood sugar levels .Patients suffering from this disease over a long period of time , get affected by a disease as diabetic retinopathy (DR) which attacks the retina .DR affects the blood vessels in the retina. It is a leading cause for various eye diseases and may even lead to blindness [1].

There are three phases of diabetic retinopathy, these are: i) non-proliferate diabetic retinopathy (NPDR) (ii) proliferate diabetic retinopathy (PDR) (iii) maculopathy [2,5].The mildest phase of DR is NPDR, in this phase, small blood vessels within the retina leak fluid or blood . The leaking fluid causes the retina to swell, developing small dot like deposits known as microanuerysms and hemorrhages [3].The next phase is PDR , in which new vessel grow on the inner surface of the retina leading to visual impairment [4]. Macula is an important part of human eye, it provides the central vision. In Diabetic Maculopathy, the macula is damaged by the fluid or protein leaked by the blood vessels [5]. The leakages cause the retina to harden and exudates (deposits of fat from the blood) occur near or on the macula [6]. Fig.1 shows the different components present in the retina these are: macula the central portion of the retina , fovea the central part of macula , optic disc (OD) , exudates and blood vessels [7]. Medical imaging has gained much popularity for computer assisted diagnosis of various diseases. In case of diabetic retinopathy Angiogram is acquired by specialists in ophthalmology clinics, and is marginally invasive, presenting a certain risk of side effects to the patient.

Thus, image processing techniques are being widely used for detecting automatic diagnosis of DR from retinal images. A technique for exudate detection uses filter banks A morphology based method uses the green layer of the retinal image and performs different morphological operators alongwith watershed transformation for exudate detection [11]. An ensemble-based method combines preprocessing and extractor techniques and uses a voting system to identify exudates[12].A active contour based model employs morphological operator and active contour based technique to identify candidate exudates on retinal images. The false detections are filtered by Naïve Bayes classifier [13]. A curvelet-based algorithm works on Fisher's linear discriminant analysis and color information to identify exudates and optical disc [14].OpticDisk is localized by backtracking the vessels to their origin. This is certainly one of the safest ways to localize the OpticDisk, but it depends on the backtracking of vessels [15].

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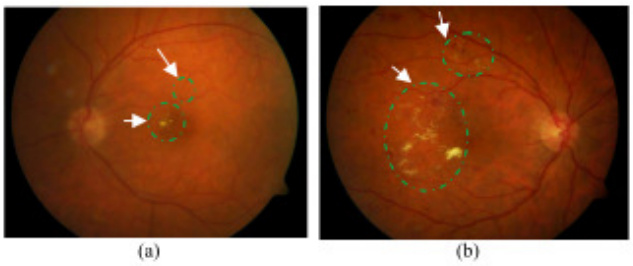


**FIGURE 1. (a) - (b) Examples of RGB color retinal images containing exudates, which are indicated by white arrows.**

There are three major complications of diabetes which lead to blindness. They are retinopathy, cataracts, and glaucoma among which diabetic retinopathy is considered as the most serious complication affecting the blood vessels in the retina. Diabetic retinopathy (DR) occurs when tiny vessels swell and leak fluid or abnormal new blood vessels grow hampering normal vision. The early stage of diabetic retinopathy is referred to as microaneurysm which appears as tiny, dark red spots or miniscule hemorrhages forming clusters with circular shape. The size varies from 10- 100 microns and it approximates to 1/12th diameter of an average optic disc. Hemorrhages, that appear inside deeper layers of the retina, form a round or flame shape. However, when they appear in large numbers, such a feature is considered as non-proliferative retinopathy. Cotton wool spots are yellowish white, fluffy lesions in the nerve fiber layer and are also called soft exudates. These spots are created as a result of swelling of the nerve fiber axons. While soft exudates are very common in diabetic retinopathy, hard exudates are typically bright, reflective and not common in diabetic retinopathy. They appear as white or cream colored lesions on the retina with different sizes. Each hard exudate consists of blood plasma and lipids leaked from blood vessels. The aim of this research is to develop a system to detect hard exudates in diabetic retinopathy using non-dilated diabetic retinopathy images. The exudates are identified using morphological methods and categorized into hard exudates and non-hard exudates using an adaptive fuzzy algorithm. Detection and treatment of diabetic retinopathy at an early stage help prevent total blindness. Therefore, early detection of diabetic retinopathy is very important because ophthalmologist would then be able to treat the patients by advanced laser treatment.

## II RELATED WORK

Divya A sajjan [1] Diabetic retinopathy is a common disease among diabetes which causes poor vision. This research provides a method for detecting the exudates in retinal images. Exudate is a type of non-proliferative retinopathy. It can be detected by applying various linear spatial filtering methods to the retinal images. Morphological operations are also applied on the preprocessed image to enhance exudates from the original image. Finally using statistical measure of randomness entropy value is used to detect the exudates.

*Jose´ Cunha-Vaza* **[2]** Diabetic Retinopathy is a major cause for blindness, identified early by the formation of exudates in the retina. The conventional method followed by opthalmogists is the regular supervision of the retina. As this method takes time and energy of the opthalmogists, a new feature based classification for the detection of exudates in color fundus image is proposed in this research. This method reduces the professionals work to examine on every fundus image rather than only on abnormal image. The exudates are separated from the fundus image by thresholding and removal of optic disk using morphological operation and connected component analysis. The features are extracted from processed image and used for classification of images as exudates and non-exudates.

Manvir Kaur et. al. **[3]** This review addresses the initial stages of non-proliferative diabetic retinopathy in diabetes type 2.The natural history of the initial lesions occurring in the diabetic retina has particular relevance for our understanding and management of diabetic retinal disease, one of the major causes of vision loss in the western world. Diabetic retinal lesions are still reversible at this stage opening entirely new opportunities for effective intervention. Four main alterations characterize these early stages of diabetic retinopathy: microaneurysms/hemorrhages, alteration of the blood–retinal barrier, capillary closure and alterations in the neuronal and glial cells of the retina.These alterations may be monitored by red-dot counting on eye fundus images and by fluorescein leakage and retinal thickness measurements. A combination of these methods through multimodal macula mapping has contributed by identifying three different phenotypes of diabetic retinopathy.They show different types and rates of progression which suggest the involvement of different susceptibility genes.

M. Niemeijer et. al**.[4]** Diabetic Retinopathy is a major cause for blindness. The primary sign of these diseases are the formation of exudate or hemorrhage which may lead to sight degradation. The conventional method followed by opthalmogists is the regular supervision of the retina. As this method takes time and energy of the opthalmogists, a feature based algorithm for the detection of exudate and hemorrhage in color fundus image is proposed in this work. This method

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reduces the professionals work to examine on every fundus image rather than only on abnormal image. The method is based on segmenting all objects that have contrast with the background including the exudate and hemorrhage. The exudates are yellow lesions formed due to the leakage of proteins and lipids from the retinal blood vessels while the hemorrhages are red lesions formed due to the leakage of blood into the interior surface of eye. The optic disc that best appear in red component are detected using Hough transform while the blood vessels that best appear in green component are extracted using morphological operations and local entropy thresholding.

M. Niemeijer et.al. **[5]** This research proposes a method for the Retinal image analysis through efficient detection of exudates and recognizes the retina to be normal or abnormal. The contrast image is enhanced by curvelet transform. Hence, morphology operators are applied to the enhanced image in order to find the retinal image ridges.A simple thresholding method along with opening and closing operation indicates the remained ridges belonging to vessels. The clustering method is used for effective detection of exudates of eye. Experimental result proves that the blood vessels and exudates can be effectively detected by applying this method on the retinal images. Fundus images of the retina were collected from a reputed eye clinic and 110 images were trained and tested in order to extract the exudates and blood vessels. In this system we use the Probabilistic Neural Network (PNN) for training and testing the pre-processed images. The results showed the retina is normal or abnormal thereby analyzing the retinal image efficiently. There is 98% accuracy in the detection of the exudates in the retina.

## III PROBLEM DEIFNITION

Diabetic retinopathy is an eye disease that's associated with long-standing diabetes. Its a major cause of poor vision. Retinopathy can occur with all type of diabetes. If left untreated, diabetic retinopathy can lead to blindness. High blood sugar level cause damage to the small blood vessels in the retina at the back of the eye. The retina is the film at the back of the eye, which receives light images and sends them to your brain. A healthy retina is essential for good vision. Different type of diabetic retinopathy diseases such as non - proliferative retinopathy, maculopathy, proliferative retinopathy. In this paper morphological operations are applied to detect and segment the exudate which is a type of non proliferative retinopathy. Finally Grey-Level Co-occurrence matrix is used to analysis the texture of a retinal image.

## IV PROPOSED WORK IMPLEMENTATION

### ENHANCEMENT

Pre-processing is the initial step in all the case of image related diagnosis system. In case of diabetic retinopathy, the retinal images in the dataset are often noisy and poorly illuminated because of unknown noise and camera settings. Also the color of the retina has wide variation from patient to patient. Thus to remove noise and undesired region the images are subjected to pre-processing steps, which include green channel extraction. The exudates appear bright in the green channel compared to red and blue channel in RGB image. [3] Hence green channel is used for further processing by neglecting other two components.

### LINEAR SPATIAL FILTERING

Filtering is a technique for modifying or enhancing an image. Image processing operations implemented with filtering include smoothing, sharpening and edge enhancement. Linear spatial filtering is filtering in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighborhood.
In this research Filtering technique is used to detect the exudates in the retinal image. The exudates are detected using Linear spatial filtering (Gaussian, Unsharp, Average) technique .First Gaussian Filter is applied to the green component. The result is taken as input and unsharp filter is applied to the image. Finally average filter is applied to the output. Three Resultant images are compared the exudates are clear after applying unsharp filter.

### INTENSITY TRANSFORMATION

The photographic negative is probably the easiest of the intensity transformations. Assume that when working with grayscale double arrays where black is 0 and white is 1.The idea is that 0's become 1's,1's become 0's and any gradients in between are also reversed. In intensity, this means that the true black becomes true white and vice versa.MATLAB has a function to create photographic negatives-imcomplement (f)

### MORPHOLOGICAL OPERATION

Morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and

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therefore are especially suited to the processing of binary images. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. The erosion of a binary image g=f s with ones in all locations(x, y) of a structuring element's origin at which that structuring element s fits the input image f, i.e. g(x, y) =1 is s fits f and 0 otherwise, repeating for all pixel coordinates (x, y).Finally erosion operation is used to detect the exudates in retinal image.

**SEGMENTATION**

Segmentation is used to segment the exudates from the retinal image. At first detect the boundary of the image using edge detection technique and dilation is applied to enhance the exudates and fill the holes and clear the border of the image and erosion is applied to segment and outline the exudates from the retinal image.

**GREY-LEVEL CO-OCCURENCE MATRIX**

The Grey-level co-occurrence matrix is a statistical method that considers the spatial relationship of pixels. [8].It is also known as the grey level spatial dependence matrix. It is used to identify the retinal image as normal or abnormal.

**ALGORITHM:-**

1) Given retinal image as input
2) Extract the red, green and blue component
3) Apply linear spatial filtering to the green component
4) Use Intensity transformation function to detect the exudates
5) Apply morphological operation erosion and the structuring element disk applied (denoted f as input image s as structure element to) produces a new binary image g=fs to enhance the exudates
6) Segment and outlined the exudates from the retinal image by using morphological operation
7) Finally Grey-Level Co-occurrence Matrix has been used analysis the texture and Plot the graph to identify the retina to be normal or abnormal

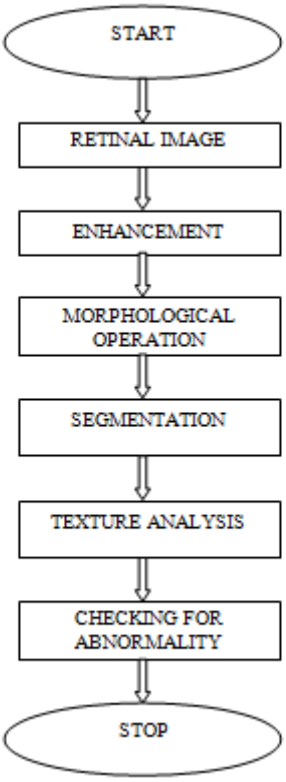


**Fig: 1** proposed work Flow in retinal analysis

## TEXTURE ANALYSIS

Texture is a property that represents the surface and structure of an image or it can be defined as a regular repetition of an element or pattern on a surface. Textures of an image are complex visual patterns that are composed of entities or regions with sub-patterns with the characteristics of brightness, color, shape, size, etc. A constant texture in an image represents a set of its characteristics that are constant, gradually changing or approximately periodic . Also, it may be regarded as a similarity grouping in an image. Texture analysis characterizes the spatial variation of image pattern based on some mathematical procedures and models to extract information from it. One of the earliest methods used for texture feature extraction was proposed by Haralick et al. back in 1973 , known as Gray-Level Co-occurrence Matrix (GLCM) and since then it has been widely used in many texture analysis applications.

Statistical methods may be used to analyze the spatial distribution of gray values by computing local features at each point in the image because spatial distribution of gray values is one of the defining qualities of texture. Statistical methods may be further classified into first-order (one pixel), second-

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order (two pixels), etc depending on the number of pixels defining the local feature of an image . GLCM estimates image properties related to second-order statistics which considers the relationship among pixels or groups of pixels (usually two). A simple one-dimensional histogram may not be useful in characterizing texture features as it is a spatial property. Hence, this two-dimensional GLCM matrix is extensively used in texture analysis and is briefly discussed here.

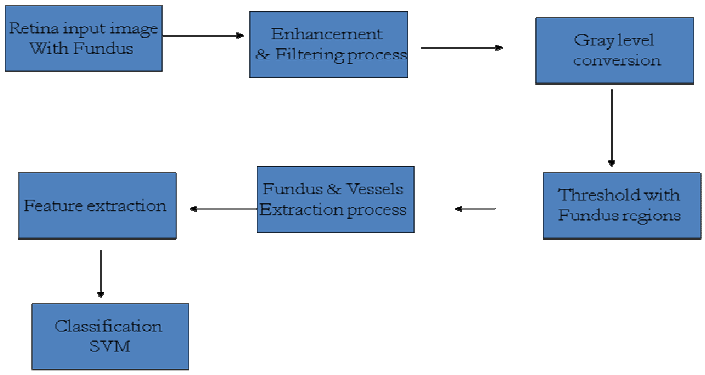


**Fig: 2** proposed work structures

## VI. EXPERIMENTAL RESULTS

The statistical measure (entropy value) is found for the processed image that can be used to differentiate the original image and exudates detected image. The entropy values for the input image ranges from 7 to 7.5 and the output after detecting exudates has range from 6 to 6.9.

**Comparative Result between Input Image& Exudates Image**

| Entropy Values (before detecting ) | Result(after Detecting Exudates) |
|---|---|
| 7.4044 | 6.9581 |
| 7.5386 | 6.7348 |
| 7.3596 | 6.7076 |
| 7.5509 | 6.6625 |
| 7.1627 | 6.6127 |
| 7.5552 | 6.9475 |
| **7.1462** | **6.2764** |
| 7.2915 | 6.8629 |
| 7.5757 | 6.6946 |
| 7.4155 | 6.9967 |

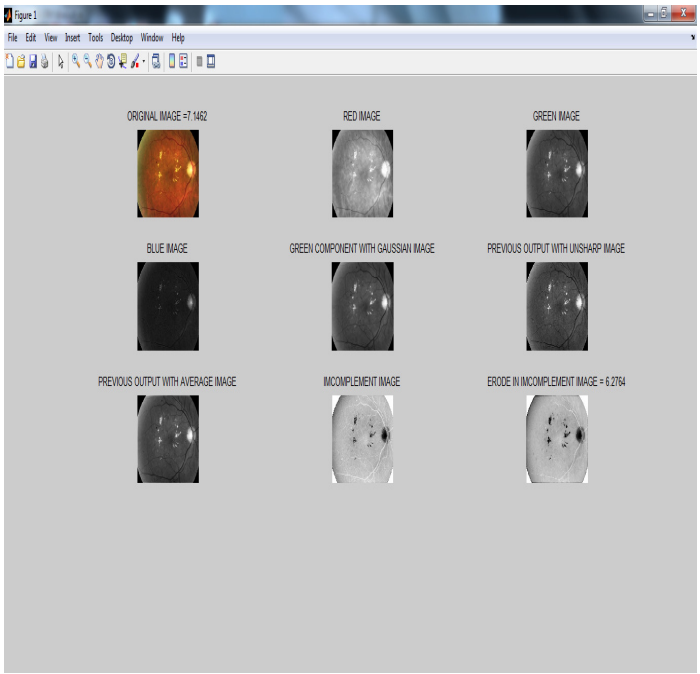


*Fig:3 output analysis of retinal image*

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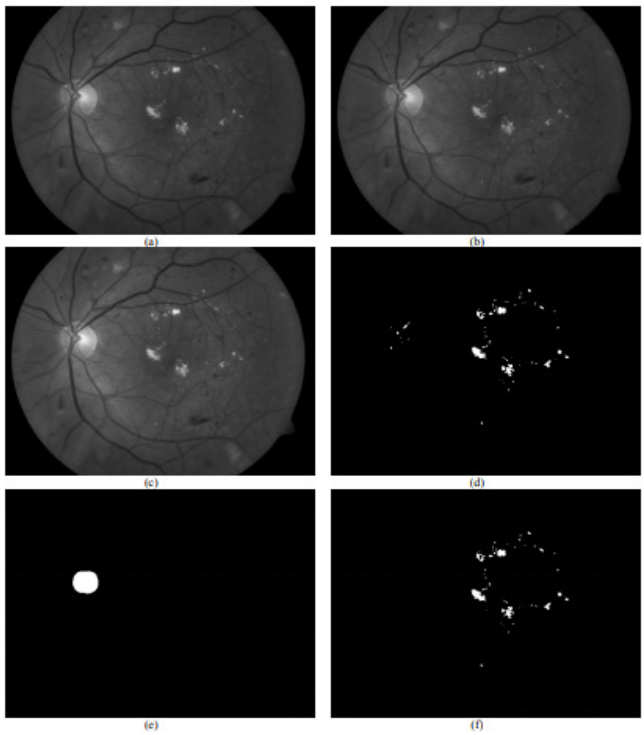

***Fig:4*** *segmented output for proposed work*

## *V CONCLUSION*

This research provides a method for detecting the exudates(non-proliferative) in Retinal images using morphological operation in Diabetic retinopathy. As a part of future Work, classification may be used to classify three types of diabetic retinopathy Diseases(non-proliferative, Maculopathy, Proliferative) will be classified by applying any one of the classification algorithm.

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