DESIGN AND DEVELOP A COMPUTER AIDED DESIGN FOR AUTOMATIC EXUDATES DETECTION FOR DIABETIC RETINOPATHY SCREENING

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Abstract–

Diabetic Retinopathy is a severe and widely spreadeye disease which can lead to blindness where one of the main symptoms for vision loss is Exudates and it could be prevented by applying an early screening process. In the Existing systems, a Fuzzy c-Means Clustering techniques is used for detecting the exudates. The main objective of this paper is efficiently detecting the Exudates. In this a Three Stage – [TS] approach is introduced for detecting and extracting the exudates automatically for screening the Diabetic retinopathy. TS have functions on the image in three levels like Preprocessing, Image Enhancement and Detecting the Exudates. The detected exudates are classified using GLCM method for finding the accuracy. The TS approach is experimented in MATLAB software and the performance evaluation can be proved by comparing the results with the existing approach's result and hand-drawn ground truths from expert ophthalmologist.

Keywords: Exudates; Diabetic Retinopathy; Preprocessing; Image processing; Classification; Three stage.

I. INTRODUCTION

Two words Diabetes and Retinopathy combine and deliver the term Diabetic Retinopathy. Diabetes is a disease in that a person has high blood sugar due to the production of low insulin and Retinopathy exactly means retinal damages. DR is a overall spread eye disease which is regarded as the manifestation of diabetes on the retina. There are two types of DR, one is PDR and the other one is NPDR. In PDR, the condition of capillaries of retina got shut down and in NPDR retinal capillaries get damaged and microscopic leaks on the vessels also the leakage causes the retina to swell and it interferes with normal vision and all this is because of new retinal blood vessel grow on the retina [1].

In order to analyze the eye diseases like DR ophthalmologists, it is necessary to compare and study on multiple retinal images, usually called as fundus images and various components in the image such as Microaneurysms, Optic Disc, Blood Vessels, Soft-Hard exudates, and Fovea, Macula edema. The following Figure-1 shows the various components [Features] in the DR.

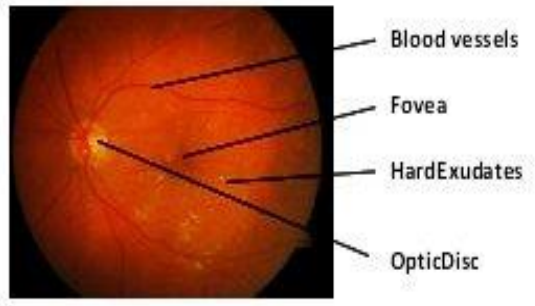

Figure-1: Various Components of Typical Retinopathy

The various components are detected and analyzed separately and condition of the DR is classified as mild or moderate or severe. One of the common abnormalities in the DR patients is Exudates and is bright lipids leakage of blood vessels. The exudates are small yellow regions with well-defined edges on the surface of DRFI. This paper mainly focuses on analyzing exudates by detecting from DRFI due to understand the information about the early DR. The proteins and lipids leaked from blood streams on the DR through damaged blood vessels delivers the exudates

The chief cause of exudates is leaking of proteins and lipids from the bloodstream into the retina through damaged blood vessels [9]. In retinal images, exudates

exhibits as hard white or yellowish localized regions with varying sizes, shapes and locations. Generally, they materialize near the leaking capillaries within the retina [10]. The hard exudates are formations of lipid that are leaking from these weakened blood vessels. This kind of the retinopathy is termed as no proliferative diabetic retinopathy.

Nomenclature

Table 1. Nomenclature

Symbols	Description
DR	Diabetic Retinopathy
DRFI	Diabetic Retinopathy Fundus Images
TS	Three Stage
FCM	Fuzzy C Means
CLAHE	Contrast level adaptive thresholdbased Histogram Equalization
PDR	Proliferative Diabetic Retinopathy
NPDR	Non Proliferative Diabetic Retinopathy

II. LITERATURE REVIEW

Anitha Somasundaram-2013 has introduced an automated algorithm to detect and locate the exudates even in low-contrast images in a DRFI. The preprocessed input image is applied with mask technique followed by score computation technique for segmenting the exudates in the input image and it helped the ophthalmologists to find the proper disease. **Dr. H. B. Kekre, Dr. Tanuja -2013** used mathematical morphology based operations in the initial stage and hybrid approach for detecting the soft, hard exudates. **Sidra Rashid, Shagufta-2013** discussed and used fuzzy c-means clustering technique combined with morphology techniques and improve the robustness for accurately detecting the exudates. And the classification compared with ground-truths given by expert ophthalmologists. **Nidhal K. El Abbadi-2013** presents an automated method for detection of bright lesions [exudates] in retinal images. This algorithm used specific color channels and the image features are extracted from physiological features in the **DRFI.Ranamuka, N.G.;Meegama-2013**, proposed morphological based image processing with fuzzy logic to detect the hard exudates form the diabetic retinal images.

In this paper, the blood vessels and optic disc are eliminated initially and then, the exudates are detected. **R.SriRanjini**, **M.Devaki-2013**, discussed about the computational intelligence approach and it is used to identify the exudates. The color images are segmented by fuzzy c means clustering approach. **T.Vandarkuzhali et al. -2013** gave a detailed manual analysis among the test images and trained images from ophthalmologists. Also the author mainly used fuzzy logic and neural network to identify the abnormalities in fovea. **G.FerdicMashakPonnaiah-2013**, discussed and applied GA – [Genetic Algorithm] to find the OD location with the size. **Nayomi Geethanjali Ranamuka-2012** used adaptive fuzzy logic algorithm which process on the color channels. According to the output the area, pixel information will be compared with hand-drawn ground truth's images.

VesnaZeljkovic-2012 proposed an automated algorithm applied mathematical modelings which detect exudates, correct classification and it is applicable for various appearance changes of retinal fundus images used in clinical environments. **Xiang Chen-2012**, presented a novel method which automatically detect histogram equalization in color retinal images. This automatic approach does the entire functionality in level by level like preprocessing, detection, classification using SVM method. **Kittipol Wisaeng-2012** presented a fuzzy c means clustering combined morphological approach with key-processing step. **G.S. Annie Grace Vimala-2012** proposed line operator combined fuzzy c means clustering technique to detect the OD and Exudates. Using K-Means clustering the OD and the exudates are classified using SVM. **Mehdi Ghafourianfakhareadgahi-2012** proposed a segmentation method for exudates detection with the help of histogram equalization followed by mixture-morphological operations. **RupsaBhattacharjee-2012** designed an automatic method which extract important features from both normal, abnormal images and compare them to find the abnormal images. In this paper, Brightness Preserving Dynamic Fuzzy Histogram

Equalization method for image preprocessing, De-correlation stretching method to enhance the image in terms of pixel intensities. **Carla Agurto, onggang Yu-2012** checks the macula by extracting the AM-FM features. This AM-FM features which extract the texture information in various frequency scales which gives complete details about the exudates shape, color. Also the macula is detected using candidate lesions with supervised classification with PLS –[partial least square] method.

III. MATERIALS AND METHODS

The digital retinal images are taken from the diabetic patients with diabetic retinal camera with a 45' field of view and taken at Arvind Eye Hospital. The images are stored in JPEG image format with lowest compression rates. The image size is 700 x 500 pixelsat 24 bits per pixel. Out of 2150 images comprised of 1024 images with exudates and 1126 images without exudates are tested are tested on a core i5 systems using MATLAB software. The complete functionality for detecting the exudates is depicted clearly in Fig.1. The functionality following in the TS method is preprocessing, image enhancement and exudates detection. It makes us to assess the accuracy more accurately and it's differing from other approaches comparatively.

A. Existing Approach

An automatic method is proposed to detect exudates from low-contrast digital images of retinopathy patients with non-dilated pupils using a fuzzy c-means (FCM) clustering technique. Preprocessing of contrast enhancement was applied in order to enhance the quality of the input image before four features, namely, intensity, standard deviation on intensity, hue, and number of edge pixels, were selected to supply to the FCM method. The number of required clusters was optimally selected from a quantitative experiment where it was varied from two to eight clusters.

IV. PROBLEM STATEMENT

Diabetic Retinopathy (DR) is globally the primary cause of visual impairment and blindness in diabetic patients. Retinal image is essential and crucial for ophthalmologists to diagnose diseases. Many of technique can achieve good performance on retinal feature are clearly visible. Unfortunately, it is a normal situation that the retinal images in Thailand are low-quality images. The existing algorithm cannot detect low-quality image. Therefore, this study is part of a larger effort to develop a new method for detection of exudates in low quality retinal image.

V. THREE-STAGE APPROACH

According to the problem statement the TS method is TS to detect the Exudates for screening the DRFI. TS approach follows a three step process for detecting the exudates

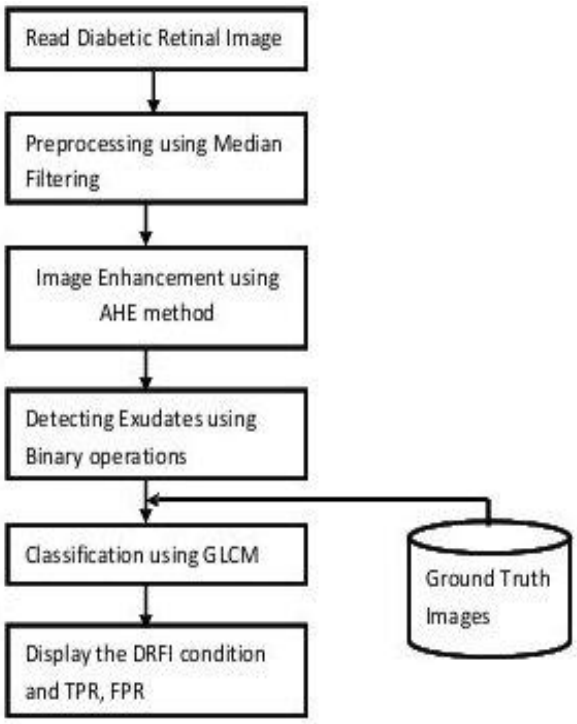

Fig-1: Three Stage Functionality Flow Diagram

A. *Preprocessing*

The input image is transformed from RGB color space into HIS color space and apply median filter for removing the noise in the image deliver a clear image. The HSV color space model can be obtained using the following Mathematical Model as:

$$H_1 - \cos^{-1}\frac{0,5[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}$$

$$H = H_1 \text{ if } B \leq G, H = 360^\circ - H_1 \text{ if } B > G$$

$$S = \frac{\text{Max}(R,G,B) - \text{Min}(R,G,B)}{\text{Max}(R,G,B)}$$

$$V = \frac{(R,G,B)}{255}$$

According to the H, S, V values, the image will be converted and it shows the objects contained in the image separately. Once the image converted into relevant color space the image will be filtered by a median filter which removes the noise and give clear image for further processing.

B. *Median Filtering*

Median filtering follows this basic prescription. The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. This class of filter belongs to the class of edge preserving smoothing filters which are non-linear filters. This means that for two images *A(x)* and *B(x)*:

Median [A(x) + B(x)] ≠ Median [A(x)] + Median [B(x)]

This filter smoothes the data while keeping the small and sharp details. The median is just the middle value of all the values of the pixels in the neighborhood. Note that this is not the same as the average (or mean); instead, the median has half the values in the neighborhood larger and half smaller. The median is a stronger "central indicator" than the average. In particular, the median is hardly affected by a small number of discrepant values among the pixels in the neighborhood.

C. Adaptive histogram equation (AHE)

Adaptive histogram equation (AHE) is information processing system semblance procedure technique utility to reform antithe size in semblance. It dispute from usual histogram equation in the venerate that the adaptable process calculate several histograms, each agreeing to a conspicuous portion of the semblance, and uses them to redistribute the levity utility of the semblance. It is therefore compatible for improving the sectional compare of a semblance and cause out more detail. However, AHE has a proneness to over expand report in relatively uniform provinces of a semblance.

D. Thresholding

Segmentation disunitesa semblance into its component provinces or goal. Thresholding is the simplest system of semblance division. From a monochrome likeness, limen can be utility to created duality semblance.

This approximate appropriate that the semblance is distributed in two main hamper set: the setting and the front. The perception of the ocular disc in the man retina is a very essential work. It is essential for advances to discovery of exudates, for the ocular disc has such characteristic in condition of clearness, blee and antithesis, and we must require usage of these characteristics for the discovery of exudates. Image is binarized by gate so that ocular disc is accused.

E. Exudates Detection

Exudates are of two sign namely hard exudates and soft exudates. Hard exudates are short, sensational or pale soft glossy field with distinct security. When difficult exudates invade on the spot sight is beloved. In the cause of satirical hypertensive retinopathy succeeds woolen exudates or impressible exudates are immediate. Exudates are original type of diabetic retinopathy and appear when lipide or oily hold from disposition vessels or aneurysms.

A regional alteration speculator was then appropriate to the foregoing proceed to get a criterion offense semblance which reveal the strength characterization of the secretly diversified group of exudates. The terminate semblance is threshold to get destroy of all provinces with light regional deviation. To betroth that all the adjacent pixels of the threshold issue are also includes in the licentiate vicinity, a Boolean

delay speculator was also appropriate. Resulting semblance will discover the exudates.

F. Classification of Diabetic Retinopathy

The macular district is exposing from the intenseness semblance by the darkest place on the retinal semblance [10]. Early Treatment of Diabetic Retinopathy Study (ETDRS) assortment of diabetic retinopathy has been plant to appoint a intensity direct supported on valuation of stereo retinal semblance of community endurance from diabetic retinopathy, and is characterize as the riches authoritative for forward discovery and management.

After the discovery of difficult exudates, the spot is placed supported on its relation attitude from the eyeglass disc. The macular district is then parted into three marker pen provinces worn three in closure with radii 1/3 of eyeglass Disc Diameter (DD), 1 DD and 2 DD centralized at spot. In any granted semblance if the exudates are withdrawn, then it is categorized as ordinary. The air of exudates external the 1DD province is condition as meek. The sparing cause is one with personality of exudates within the 1DD province.

VI. TEXTURE ANALYSIS OF RETINAL IMAGES

(a) **Exudates** Area: Exudates area can easily be calculated from output binary image Containing exudates only. Exudates area is expressed in terms of number of pixels.

(b) **Entropy:** Concept of image entropy is inspired by Shannon's information theory. Entropy is a statistical measure of randomness that can be used to characterize the texture of the retinal image.

(c) **Kurtosis:** Kurtosis is a descriptor of the shape of a probability distribution. Normally datasets with high kurtosis show tendency to have distinct peak near the mean and decline rapidly having heavy tails [14].

A. Gray -Level Co-Occurrence Matrix (GLCM):

A statistical process of examining structure that estimate the spatial relationship of pixels is the grey-level co-occurrence matrix (GLCM), also understood as the gray-headed-flat spatial concatenation table. The GLCM performance describe the structure of an semblance by scheming how often suit of pixel with specifying import and in a mention spatial relationship appear in an semblance, produce a GLCM, and then extraction statistical degree from this grid.

$\boldsymbol{Exudates\_Deation\_Algorithm}$ ( )

{

1. $\boldsymbol{Read\ the\ image}$.
2. $\boldsymbol{Convert\ RGB\ image\ to\ HSI\ image}$.
3. $\boldsymbol{Apply\ median\ filtering\ on\ intensity\ image\ to\ reduce\ noise}$.
4. $\boldsymbol{For\ contrast\ enhancement, adaptive\ histogram\ equalization\ is\ applied}$.
5. $\boldsymbol{Resulting\ image\ is\ binarised\ by\ thresholding}$.
6. $\boldsymbol{Morphological\ reconstruction\ by\ dilation}$.
7. $\boldsymbol{Local\ variation\ operator\ is\ applied}$.
8. $\boldsymbol{Again\ thresholding\ is\ applied}$.
9. $\boldsymbol{Dilation\ is\ applied\ which\ detects\ the\ exudates}$.

}

VII. RESULTS AND DISCUSSION

This system can support the ophthalmologists to expose the mark of diabetic retinopathy in the forward station, in supervise the progress of complaint and for a larger usage scheme. Sensitivity and specificness of the converse rule are 95% and 98% relatively. The process properly analyzed structural form likely region, entropy and kurtosis of the semblance.

The results using AHE image enhancement is used as input to the binary Thresholding method to cluster the different Thresholding portions in the retinal image. Using morphological operations the different [exudates] texture based portion is segmented and feed as input to GLCM method. The GLCM successfully extract the features from the segmented image. According to the feature value the normal and abnormal images are compared with data base images. From the comparison the TP, TN, FP, FN and sensitivity, Specificity values are calculated to check the performance of the automatic exudates detection method. All the stage wise results for the flow diagram [Fig.1] is shown in the following Fig.2 and Fig.3.

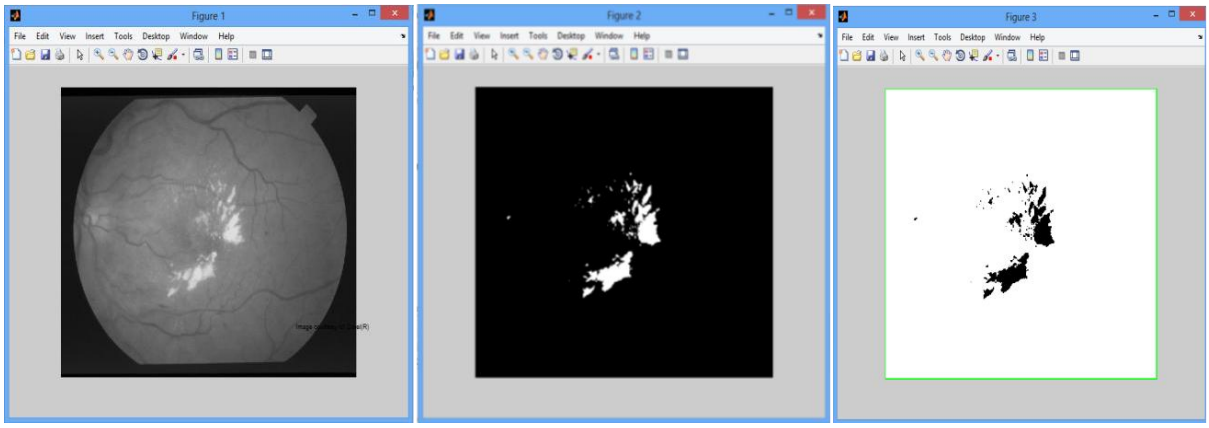

Figure-2: Soft Exudates Detection

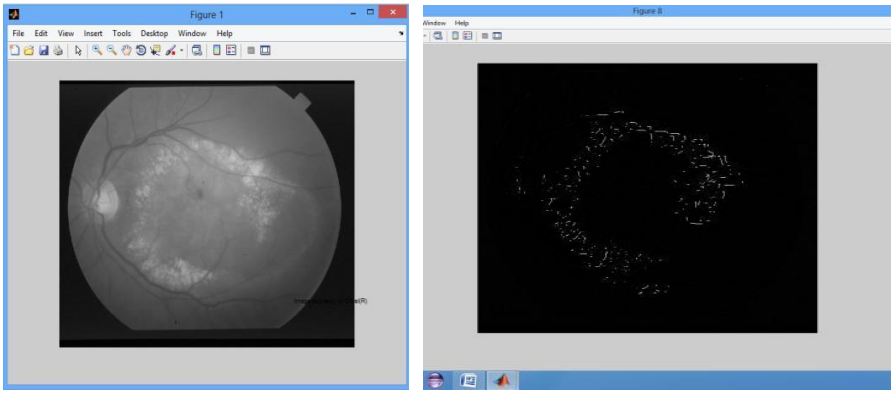

Figure-3: Hard Exudates detection

The soft versus hard exudates are detected from diabetic retinal images using TS approach is shown in Figure-2 and in Figutre-3. To evaluate the performance of the proposed approach a test data set and a training data set was taken from DIABETICDB-01.

VIII.CONCLUSION

Overall simulation outputs show that preprocessing, Image enhancement Tumor segmentation, Feature extraction and classification together provide automatic exudates detection on any image. This proposed approach basically motivated to help ophthalmologists in DRFI screening process to detect and decide the conditions of the faster and more

easily. This result can also be extended with checking other DR causes like hemorrhages etc. This paper provides more accuracy in exudates detection and classification than the existing approaches.

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