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RETINAL BLOOD VESSEL ZONING

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Abstract:

The common method image enhancement is used in histogram equalization .histogram is used to contrast the entire image by this we can reduce the noise in that image but in histogram equalization we will remove the noise on entire image which is not suitable for some applications bit in CLAHE (contrast limited adapting histogram equalization) method is based on adaptive histogram equalization in this method we perform contrast on small regions where our needed and in thus method by using block side and clip limit we will enhance the image in this general we propose a method using green background clahe method to improve the enhancement process of an image.

Keywords — **Image Enhancement, Equalization, Histogram, Clahe**

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1. INTRODUCTION

Diabetes is a disease in which malfunctionalities in glucose metabolism gives to increased glucose levels in blood. Diabetic retinopathy is one of the important complications caused due to prolonged diabetes. The percentage of worldwide population affected by diabetes is expanding with an increasing rate. Aging population, physical inactivity and increasing levels of obesity are contributing factors to the increase in the prevalence of diabetes.

From the statistics of World Health Organization the global generality of diabetes is expected to a height from 130 million to 300 million in next 2 decades. People with semi finished diabetes are 25 times more at dangerous for blindness than the general population.

In order to categorise diabetic retinopathy the medical specialist consider the area observed by healthy blood vessels. The area observed by the healthy blood vessels is large in a normal eye differentiate to the eye over down by DR. Hence, it is essential to estimate the area observed by blood vessels to mark and grade DR.

The process of segregating the segments of retinal images that are vessels from rest of the image is known as vessel extraction. This task is convoluted due to factors such as poor contrast between vessels and background, presence of noise, varying levels of illuminations and contrast across the image, physical irregularity of vessels and presence of pathologies. All these factors yield different results.

Different methods yield distinctly different results and even the same method will yield different results for images taken from the same patient in a single session. These differences become significant for images taken at different points in time as they could be mistaken as changes. The methods used to determine the vessels boundaries should strive to lessen the frequency and severity of these inconsistencies.

There are various causes for detecting blood vessels, ranging from a need to identify vessel locations to aid in reducing false-detection of other scratches, to detecting the vessel network to establish their geometrical relationships or identifying the field-of-view of the retina, to accurate presentation of the vessels for quantitative measurement of various parameters such as width, branching ratios for identifying vessel features such as venous dilation and arteriolar narrowing.

In, algorithms to delineate the network in fluoresce in retinal images are presented. In algorithms that work on color fundus images are presented. Matched filtering approach followed by threshold probing is presented. The algorithms that use mathematical morphology are presented in. Various other methods including multi threshold probing, wavelet analysis and many more methods.

From the conclusion, it is clear that various blood vessel extraction algorithms are designed but very few have made an attempt to extract blood vessels in order to grade diabetic retinopathy. This motivated us to work towards extraction of only healthy blood vessels from the fundus images. Since morphological operations have proven their ability in extracting shape based features, we use them in designing blood vessel extraction algorithm.

As per studies, in India by the year 2015 around 15 percent of the population are affected by diabetes and within 5 years span these diabetes patients will develop severe symptoms of diabetic retinopathy eventually leading to blindness. Hence it is evident that in immediate future issues related to DR will become significant and will require proper attention.

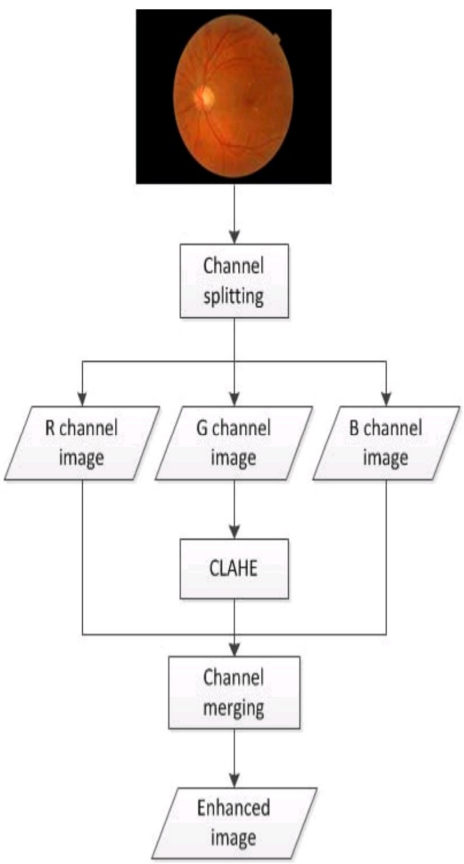

Fig 1 : Block diagram of proposed method.

2. LITERATURE REVIEW

Birendra biswall, thotakera pooja, N.bala subrahmanyam [1] presented a method for robust retinal blood vessel segmentation using detectors. This method uses a linear combination of line detectors at varying scales along with multiple windows of different sizes. In this technique, the drawbacks encountered in multi-scale line detection such as noise, false vessel detection around the optic disk are removed. The proposed method is evaluated on available datasets are DRIVE, STARE and CHASE by considering sensitivity, specificity, accuracy, precision, false discovery rate, F1 score, Matthews correlation coefficient and G-mean. The result was to achieve higher accuracy. The high-resolute of retinal images together with better simplicity and faster implementation for reliable blood vessel segmentation.

Zafer yavuz and cemal kose [2] presented a method for the blood vessel extraction in color retinal fundus images. The different methods are pre-processing stage in order to prepare dataset for segmentations and an enhancement procedure including Gabor and Gauss filters obtained separately before a top-hat transform and a hard and soft clustering stage which includes K-means and Fuzzy C-means (FCM) in order to get binary vessel map. Finally, a post processing step which removes falsely segmented isolated regions. The result for Gabor filter followed by K-means clustering method achieves 95.94% and 95.71% of accuracy for STARE and DRIVE databases, respectively.

M.Anto Bennet,D. Dharni, S.Mathi Priyadavnini, N.Lakshmi Mounica [3]:In this method adaptive filters in blood vessel segmentation in retinal images. The adaptive filters are classified into median filtering, histogram equalization, entropy filtered image, threshold image and vessel tracking. The Segmentation of blood vessels in retinal images allows early diagnosis of disease; this process provides several benefits including minimizing subjectivity and eliminating a painstaking, tedious task. A method is designed to solve this optimization problem and show that the proposed approach is able to achieve good pixel precision and recalls all true vessels for clean segmentation retinal images, and remains robust even when the segmented image is noisy.

Joythi Prava Dash,Nilamani Bho [4]: proposed method for a Fundus images are consistently used for the analysis of numerous pathological syndromes. This paper presents a three step thresholding based method to extract the blood vessels from the retinal images. In the first step a unique combination of principal component analysis (PCA) and contrast limited adaptive histogram equalization (CLAHE) is used to enhance the retinal images. In the second step the blood vessels are extracted with the help of global Otsu thresholding method. Finally in the last step morphological cleaning is applied to remove unwanted frills. The proposed method enables implementation to be easier and takes less computational time. The two publicly available DRIVE and STARE databases are taken for evaluation of the performance of the presented method. It achieves an average accuracy, sensitivity and specificity about 0.956, 0.723 and 0.984 for DRIVE database while 0.954, 0.737 and 0.982 for STARE database respectively.

Wahyudi Setiawan,Monammd Imam Utoyo and Riries Rulaningtyas [5]: proposed methods for modified morphology based on Retinal vessel segmentation. The segmentation of a blood vessel image aims to extract vascular objects from the fundus image. The first study used three steps: pre-processing, segmentation and classification. Pre-processing aims to convert the RGB image into greyscale and green channel images and uses a basic line detector to remove the central vessel reflex. The segmentation uses thresholding and classification using Support Vector Machine. The results using the Digital Retinal Images of Vessel (DRIVE) dataset showed an accuracy of 95.95%, while trials using the STARE dataset showed an accuracy of 96.46%.22.

In [6] :presented a multi-concavity model based on Regularization to detect retinal blood vessels from pathologically effected and non effected retinal images. In proposed method blood vessels are detected when there is red lesions either bright or dark are present in retinal images. At first in proposed method a concavity measure is performed to detect and remove the bright lesions. To remove dark lesions a line shape based concavity measure is used, the detection of dark lesion is based on the difference in intensity structure in blood vessels and dark lesions. Then a normalized concavity measure is use to deal with irregularly spread noise in retinal images. Results from all three concavity measurement are combined to detect the blood vessel successfully. The proposed method provides efficient retinal blood vessel segmentation in both healthy and unhealthy retinal images in single experiment.

Syed Ayaz et al. [7] proposed a new algorithm of blood vessel segmentation based on regional and Hessian features for image analysis in retinal abnormality diagnosis. In it a lot of emphasis is given on image enhancement. A 24-D feature vector is used to classify the pixels. LMSE (linear minimum squared error) classifier was used for the classification purposes. The algorithm was applied on the DRIVE database and an accuracy of 0.9479 and sensitivity of 0.7205 is obtained. This algorithm is particularly good at detecting blood vessels at the per papillary region with a limitation that such a huge feature vector needs lots of computational time.

Chakraborti et al [8] has developed the vessel pattern extraction filter with the self-adaption capability to the variations in the retinal samples. The pertaining combination of the highly sensitive vessel extraction filter along with histogram orientation method has been realized for the purpose of vessel structure extraction. The Hessian matrix has been applied over the Eigen-analysis programmed in the different intensity based scales, which further undergoes the variable intensity ranges. The scalable Gaussian filtering has been arranged in the linear fashion over the pre-processed samples with Eigen-analysis using Hessian Matrix for the precision based pattern outlining. The lower value of the Sensitivity parameter (72% for DRIVE database, 67% for STARE database & 53% for CHASE database) indicates the presence of false negative cases in the higher density, which is the possible area of improvement in order to create the robust blood vessel extraction method.

In [9] proposed a multiscale line detection method for segmentation of retinal blood vessel from retinal images. Multiscale Line Detection method is an improved method Basic Line Detection method. The multidirectional morphological top hat transformation is used to homogenize the background. Basic line detection method is based on orientation of line on each pixel in retinal images. The improved multiscale line detection method is work similarly but uses multiple lines at once to detect the vessel response. The proposed method is tested on dataset available publically and is compared with basic line detection method. The results shows that the proposed method gives the improved results than the basic line detector with efficient blood vessel segmentation.

Roychowdhury S. and Koozekanani D. D , Parhi K K [10]: Presented a method for blood vessel segmentation from retinal images by performing operation in three stages. At first they obtain two binary images after performing high pass filtering and morphological Top-hat transformation on green panel of the original image. Then extract the region common in both binary images as major vessels. A Gaussian Mixture Model is used as classifier to extract the features from the remaining pixel in both the binary images. Features are also extracted from first and second order gradient images of the two binary images. Major vessels and the classified vessel pixels are combine together to get the desired blood vessels. The proposed algorithm provide efficient results than the previous methods. It took less time and is less dependent on training data. The results shows that the proposed method takes low computational time and provide efficient results than the previous methods.

CDC, (2011, Mar.). Diabetic retinopathy. Atlanta, [11] they presented a paper in which they introduce a method for segmentation and measurement of blood vessels in retinal images. They use an active contour model "Ribbon Of Twins" to extract the vessel edges, this model uses two pairs of contour for capturing vessels edges. They first uses Morphological order filter to detect the vessel centrelines. After this operation they uses the Tramline Algorithm for mapping of vessel center-line which neglects the vessel junction only maps the detected center lines and after this for final blood vessel segmentation they uses ROT(Ribbon Of Twins) active contour method for final vessels segmentation. The Proposed method is also used for measuring vessel width. The results shows that they provide better segmentation of retinal blood vessels and efficient measurement performance.

3. PROPOSED METHOD

CLAH (Contrast Limited Adaptive Histogram Equalization) **method:**

.It is proposed to improve image contrast for medical image applications to overcome the noise problems and to improve contrast. CLAHE method produces the optimal equalization in terms of maximum entropy and also limits the contrast of an image. This method is applicable for both gray and colour images. Method divides the image into corresponding region and finds the equalization to each region.

Algorithm:-

Step1:- Divide all the input images into $M \times N$ matrix of sub-images or tiles of equal size.

Step 2: Calculate the intensity histogram of each tile.

$$Probability = \frac{Number\ of\ COnditions}{Total\ number\ of\ COnditions}\ .$$

$$Cumulative\ Probability = p(i) + p(i-1)$$

Step 3: Set the clip limits for clipping the histogram. The clip limit is a threshold parameter. Higher clip limits increases the contrast of local image regions thus it must be set to minimum possible value.

Step 4: Modified the each histogram by the appropriate transformation functions.

Transformation function $= \frac{C}{MN}$.

Where C is cumulative frequency.

MN product of the image size.

Step 5: All histograms are transformed in such a way that its height did not exceed the clip limit. The mathematical expression for transformed gray levels for CLAHE method with Uniform

Distribution can be given as

$$g = [\, g_{max} - g_{min}\,]\ p(f) \ + \ g_{min}$$

where g_{max} = Maximum pixel value

g_{min} = Minimum pixel value

g = is the computed pixel value

p(f) =CPD (Cumulative probability distribution)

For exponential distribution the gray level can be choosen as

$$g = g_{min} - \frac{1}{a} \ln[\, 1 - p(f)]$$

Where a is the clip parameter

CLAHE method enhance the small regions in the image, called "tiles", rather than the entire image. So that the histogram of the output region almost equal to the histogram specified by the distribution type. The CDF of Rayleigh distribution is given as;

$$y = p(f(x(b)) = integral\ (\frac{x}{b^2}\ \ e^{-x^2/_{2b^2}}$$

Step 6: All neighbouring tiles were combined using bilinear interpolation and the image grayscale values were inversed according to the modified histograms.

4. RESULT

In this paper, we propose a enhanced method using clahe in G-channel to improve the quality of colour retinal image. Thus, we calculated the accuracy by using the co-relation by comparing the original image with the enhanced image with an accuracy of 94.3%.

Fig 2(a):Input Image

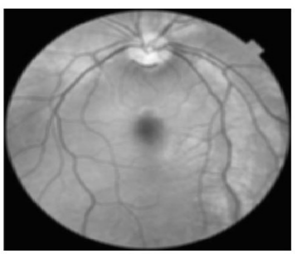

Fig 2(b):Gray Image

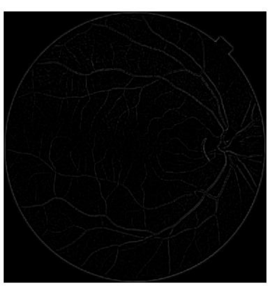

Fig 2(c): Filtered Image

Fig 2(d) :Output Image

Serial number	Image Number	Accuracy
1	Retinal image 1	94.2
2	Retinal image 2	92.3
3	Retinal image 3	84.6
4	Retinal image 4	83.2
5	Retinal image 5	86.5
6	Retinal image 6	85.7
7	Retinal image 7	84.45
8	Retinal image 8	87.14
9	Retinal image 9	81.22
10	Retinal image 10	90.3

Table 1 : Accuracy evaluation for different retinal images

CONCLUSION:

In this paper we propose a enhanced method using CLAHE in G channel to improve the colour retinal image quality we can conclude that the enhancement process conducting g channel is appropriate to enhance the colour retinal image quality in this paper we use visual observation to asses the enhanced images and compare them with original images next development is to conduct quantitative method to access the enhanced image.

REFERENCES:

1.Birendra biswall, thotakera pooja, N.bala subrahmanyam: “ a robust retinal blood vessel segmentation using dectors”

2.Zafer yavuz and cemal kose:” method for the blood vessel extraction in color retinal fundus images”

3.Sahinaz Safari sanjani,Jean Baptiste boin, karianne Bergen: “method for blood vessel in retinal fundus images”

4.M.anto Bennet, D.dharni, s.mathi priya davnini, N.lakshmi mounica: " method for adaptive filters in blood vessel segmentation in retinal images"

5.Joythi prava dash,nilamani bhoi: "Fundus images are consistently used for the analysis of numerous pathological syndromes"

6.Wahyudi setiawan,monammd imam utoyo and riries rulaningtyas: "methods for modified morphology baded on Retinal vessel segmentation"

6.Benson S. Y. Lam, Gao Y, and Alan Wee-Chung Liew, "General Retinal Vessel Segmentation Using Regularization-based multiconcavity modeling" IEEE Transaction on medical Imaging, Vol. 29, No. 7, July 2010

7.Syed Ayaz et al., "Blood vessel segmentation in color fundus images based on regional and Hessian features", Graefes Arch Clin Exp Ophthalmol, 2017.

8.Tapabrata Chakraborti et a;, "A self-adaptive matched filter for retinal blood vessel detection", Machine Vision and Applications, 2014.

9. Hou Y "Automatic segmentation of retinal blood vessels based on improved multiscale line detetction, Journal of computing science and engineering, Vol. 8, No. 2, pp. 119-128, June 2014.

10.Roychowdhury S. and Koozekanani D. D , Parhi K K "Blood vessel segmentation of fundus images by major vessel extraction and sub-image classification" IEEE Journal of Bio-medical and health informatics, 2013.

11. CDC, (2011, Mar.). Diabetic retinopathy. Atlanta, GA: National for chronic disease prevention and health promotion [Online]. Available: http://www.cdc.gov/visionhealth/pdf/factsheet.pdf

12. H. M. Pakter, S. C. Fuchs, M. K. Maestri, L. B. Moreira, L. M. Dei Ricardi, V. F. Pamplona, M. M. Oliveira, and F. D. Fuchs, "Computer-assisted methods to evaluate retinal vascular caliber: What are they measuring?" Investigative Ophthalmol. Visual Sci., vol. 52, no. 2, pp. 810–815, 2011.

13. K. Kotliar, E. Nagel, W. Vilser, S.-F. Seidova, and I. Lanzl, "Microstructural alterations of retinal arterial blood column along the vessel axis in systemic hypertension," Investigative Ophthalmol. Visual Sci., vol. 51, no. 4, pp. 2165–2172, 2010.

14. A. Kochkorov, K. Gugleta, C. Zawinka, R. Katamay, J. Flammer, and S. Orgul, "Short-term retinal vessel diameter variability in relation to the history of cold extremities," Investigative Ophthalmol. Visual Sci., vol. 47, no. 9, pp. 4026–4033, 2006.

15. E. Nagel, W. Vilser, and I. Lanzl, "Age, blood pressure, and vessel diameter as factors influencing the arterial retinal flicker response," Investigative Ophthalmol. Visual Sci., vol. 45, no. 5, pp. 1486–1492, 2004.

16. S. Roychowdhury, D. D. Koozekanani, and K. K. Parhi, "Screening fundus images for diabetic retinopathy," in Proc. Conf. Record 46th Asilomar Conf. Signals, Syst. Comput., 2012, pp. 1641–1645.

17.S. Roychowdhury, D. Koozekanani, and K. Parhi, "Dream: Diabetic retinopathy analysis using machine learning," IEEE J. Biomed. Health Informat., no. 99, Dec. 2013, doi: 10.1109/JBHI.2013.2294635.

18.M. Fraz, P. Remagnino, A. Hoppe, B. Uyyanonvara, A. Rudnicka, C. Owen, and S. Barman, "An ensemble classification-based approach applied to retinal blood vessel segmentation," IEEE Trans. Biomed. Eng., vol. 59, no. 9, pp. 2538–2548, Sep. 2012.

19. D. Marin, A. Aquino, M. Gegundez-Arias, and J. Bravo, "A new supervised method for blood vessel segmentation in retinal images by using gray-level and moment invariants-based features," IEEE Trans. Med. Imag., vol. 30, no. 1, pp. 146–158, Jan. 2011.

20. M. Fraz, P. Remagnino, A. Hoppe, B. Uyyanonvara, A. Rudnicka, C. Owen, and S. Barman, "Blood vessel segmentation methodologies in retinal images a survey," Comput. Methods Programs Biomed., vol. 108, no. 1, pp. 407–433, 2012.

21. A. Hoover, V. Kouznetsova, and M. Goldbaum, "Locating blood vessels in retinal images by piecewise threshold probing of a matched filter response," IEEE Trans. Med. Imag., vol. 19, no. 3, pp. 203–210, Mar. 2000

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