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SMART DIABETIC ASSESSMENT SYSTEM FOR DIABETIC RETINOPATHY USING RETINAL IMAGE EXAMINATION

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ABSTRACT

Diabetic Retinopathy (DR) is the main cause of blindness in the world. Smart diabetic assessment System showing is suitable tool for Early Treatment of Diabetic Retinopathy Study (ETDRS) for diabetic retinopathy using retinal fundus image examination. A number of computer assisted analysis helps ophthalmologists to judgment the severity of diabetic retinopathy but still the annual screening of retinal images is very significant to perceive diabetic retinopathy(DR) by an spontaneous assessment system for examining the images through region based method, filtering techniques and thresholding methods. This article offers a review and examination on a smart diabetic assessment system for diabetic retinopathy using retinal fundus image analysis so that it can be used to indication the irregularities like microanuerysms, hemorrhages, hard exudates, soft executes in the non-proliferative diabetic retinopathy.

KEYWORDS: Assessment, Exudates, Filtering, Region Growing, Thresholding

1. INTRODUCTION

Diabetic retinopathy is the highest effect on society, which is produced due to the excessive release of insulin in the blood. Forth prominent cause of impaired vision and fifth leading reason of visual deficiency due to diabetic retinopathy in the world There are 285 million people are vision impaired, 39.3 million persons were blind projected in 2010, More than 80% of persons by visual impairments live in lower income group, More than 80% of persons blind are more than 50 years old, Diabetic retinopathy is the cause of visual impairment for 42 lakh people.

Numerous image processing methods develops to detect the diabetic retinal irregularities like microaneurysms, hemorrhages, red or dark exudates, yellow or white spot, macular edema in retinal fundus images. This is very significant to monitor the retinal images of the diabetic patients yearly. Major classifications of Diabetic Retinopathy (DR) are non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). NPDR is again classified as minimal mild, moderate and severe, very severe stages and several phase of proliferative diabetic retinopathy. Blood vessels are having computable changes in diameter, angles, branching etc. In the early stages, due to bad intensity, illumination, contrast, poor quality cameras, reflections were the main problems, which hold the problems of the ophthalmologists to monitor the retinal images. Diabetic retinopathy creates vision harm of the patients.

There is a need for regular treatment of the diseases. In the analysis of the fundus images of retinal image, certain undesirable disturbances like illumination diminishing, background noises; preprocessing plays an important role in decreasing the background noises and enhanced contrast.

The smart diabetic assessment system detects diabetic like optic disk, macular edema, fovea, microaneurysms, hemorrhages, hard exudates, soft exudates by region growing, thresholding, and filtering etc. methods have been detected.

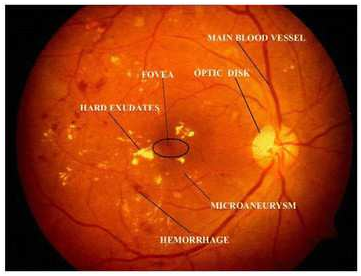

Figure 1: Architecture of Retinal Image

The construction of a retina image viewing the different parts shown in Figure 1 Microanuerysms (30-120 micron diameter) which is a first stage of diabetic appears as red dots lesion is called mild non-proliferative diabetic retinopathy. Dot and blot hemorrhages Flame shaped hemorrhages is leakage of thin weak capillaries with irregular margin is known a moderate non-proliferative stage of diabetic retinopathy, hard exudates occurs in the outer layer of the retinal walls, which appears as the yellowish spots with sharp margins, Soft Exudates looks as white lesions which develops due to occlusion.

The rest of the paper is prepared as follows: section 2 deliberates the many techniques detection of diabetic retinopathy, section 3 contributes a description about the article with the review table of several techniques and lastly the paper is finished in section 4.

2. SMART DIABETIC CALCULATION METHOD FOR DIABETIC RETINOPATHY USING SEVERAL TECHNIQUES

The finding of diabetic retinopathy by a smart assessment system for examining the images is done using region based method, filtering techniques and thresholding techniques. Those techniques are talk over one by one in the subsequent section.

2.1. Matched Filter

H.A. Nugroho [1] proposed a new algorithm for the automated microaneurysms (MAs) detection in digital color fundus images using matched filter. Generally, the algorithm consists of four phases, namely green band extraction, MAs and blood vessels isolation, MAs and blood vessels detection, and blood vessels removal. To validate the developed algorithm, the results are compared with their ground truths and annotations using ROI based validation. This algorithm obtains an average sensitivity, specificity, accuracy, and false positive number of 91.0603%, 99.9752%, 99.9752% and 256.44 pixels, respectively. Proposed algorithm successfully detects microaneurysms and is able to be implemented in a system for DR mass screening purposes.

J. Prakash Medhi et al. [2] developed an algorithm to identify the approach of fovea in retinal fundus image. In this method, OD location information is not required. The algorithm first searches fovea location then it's detect the region of interest. The method also detect of vascular pattern and vessel free area using morphological image processing tools. The overall accuracy is 98.21% is experienced on DRIVE, DB0, DB1, LOCAL, MESSIDOR and HRF data banks comprising both normal and extreme cases of DR.

2.2. Region Based Method

N. Sengar et al. [3] proposed to detect the macula centre and grading of diabetic macular edema is done by dividing dissimilar regions according to the international standard in retinal images. Disease severity is accessed using scaling of bright lesions in macular regions. In this method search region for detection of macula is adaptive to the size of image. The proposed method has achieved good accuracy 80 to 90 % is tested on 100 images of MESSIDOR database.

2.3. Median Filtering and Morphological Reconstruction

Ahmed Wasif Reza et al. [4] proposed a novel concept for recognition of blood vessels using median filtering and morphological operations in retinal image. The post filtration and morphological reconstruction assist in filling the edges of the blood vessels and removing the false alarms and unwanted objects from the background. The proposed method tested on various images of publicly available database yield 0.77 true positive fraction values.

2.4. Region Based Segmentation Method

Malay Kishore Dutta et al [5] proposed algorithm provides an effective grading technique by segmenting the fundus image into exact ROI and sidesteps redundancy in calculation. The proposed method highlights on the segmented regions for the abnormalities instead of detecting anomalies for the entire image, thus decreasing the calculation time considerably. Also, this approach delivers a simple and direct method to measure the severity of the disease. The accuracy of this region based segmentation method is more than 80% when tested in a database.

2.5. Gabor Filter with Local Entropy Thresholding

Kuri et al. [6] proposed system extract retinal vessels in retinal image using Gabor filter and local entropy thresholding technique. Removal of blood vessels pixels are classified by local entropy thresholding technique. The frequency and orientation of Gabor filter are tuned to match that of a part of blood vessels to be enhanced in a green channel image. The performance of the proposed algorithm is analysed by MATLAB software with DRIVE database.

P.R. Patel et al [7] proposed a three phase system in which first stage extracts all possible candidate sores existing in a fundus image using Gabor filtering. Then feature sets are computed for each candidate lesion using different properties and features followed by classification of injuries. The assessment of projected system is realized by retinal image data bases with the help of dissimilar performance grounds and the results display the strength of suggested method.

2.6. Template Matching and Morphological Procedure Method

Geetharamani et al [8] proposed the method using template matching method and morphological procedure to fragment and restrict the OD region of retinal fundus images. The proposed frame work without consider diameter and center point of retinal image and it act as a key area to detect the retinal diseases by CDR ratio and the ratio between Optic rim & center of the optic Disc that comprises of 30 retinal fundus images of gold standard database. The optic disc centers & diameter recognized through our technique are near close to ground truth provided by the ophthalmologist specialists. The proposed system succeeds 98.7%.

2.7. Adaptive Threshold and Morphological Operators

Enrico Grisan et al [9] proposed to detect and recognize hemorrhages (red) lesions in fundus images using a simple local thresholding method followed by an evaluation of a measure of the spatial density of the pixels selected at the

first step. For noble performance in term of false candidate rejection, to evaluate the algorithm on 6 images offering dark lesions extracted from a database of 60 annotated images. The performance detection rate of 94%.

Subramanian Ganesan et al [10] suggested to measure exudates and drusen (AMD), a preprocessing takes place, in which first exudates and drusens detection and segmentation were implemented. For these implemented processes, applied preprocessing operations then the combined approaches for image segmentation and classification were implemented using two methods of texture, an adaptive threshold, and morphological operators. After put on these approaches to a number of images providing from ophthalmologists as well as Drive database, this automated diagnostic algorithm resulted in more accurate yields of exudates and Drusens detection and measurements especially for low intensity and less color contrast images from non-dilated eye pupils.

2.8. Morphological, Filtering and Thresholding

Arulmozhivarman Pachiyappan et al [11] described a method for the computerized analysis of diabetic retinopathy and glaucoma using fundus and OCT images. The macular irregularities caused due to diabetic retinopathy can be detected by put on morphological techniques, filtering and thresholding on the fundus images. The algorithm was tested on a set of 89 fundus images and OCT 31 images. The accuracy for optical disk detection is found to be 97.75%. The projected system therefore is accurate, reliable and robust and can be realized.

2.9. Thresholding

Marwan D. Saleh et al. [12] provides a computerized diagnosis system for DR to extracts some retinal features, such as optic disc, fovea, and retinal tissue for easier segmentation of dark spot lesions in the fundus images using thresholding and h-maxima transformation. The method is followed by the classification based on the number and location of microaneurysms and hemorrhages then measures the severity level of diabetic retinopathy. The developed system tested on 98 color retinal images with the sensitivity and specificity values of 89.47% and 95.65%.

2.10. Multilayered Thresholding

M. Usman Akram et al [13] proposed a new method for detection of abnormal blood pattern and optic disk using Hough transform and multilayered thresholding method. Grading of PDR using multivariate m-Mediods based classifier. It grades the fundus image in different categories of proliferative diabetic retinopathy using classification and optic disc coordinates. The proposed system grade and detect PDR with high accuracy evaluated by publicly available retinal image databases.

2.11. 2D-Match (Gabor) Filters and Hysteresis Thresholding

Girish Singh et al [14] presented a systematic methodology using contrast limited adaptive histogram and gabor filter to segment blood pattern to the diagnosis of proliferative diabetic retinopathy from retinal fundus images. The method enhanced the vascular patter and remove background noise. It is extract blood vessels with 93.1 % accuracy through hysteresis thresholding techniques in comparison with the ground truth images provided in the DRIVE database.

2.12. Dynamic Thresholding

A.V. Sagar et al [15] presented an algorithm to segment of optical disk boundaries using integrated dynamic thresholding edge detection (IDTED) technique. It has pre-processing techniques such as contrast enhancement and histogram equalization. Local contrast enhancement is integrated with dynamic thresholding (DT) and edge detection for

exudate detection. The algorithm shown 93% predictively and 99% sensitivity testing on 25 digital fundus retinal images

2.13. Median Filter

Priyakshi Bharali et al. [16] presented a computerized assisted method for detection of red lesions dots in retinal fundus images using median filtering. In first phase, vascular pattern is identified, eliminated then hemorrhage lesions is detected. The proposed method displays an overall sensitivity of 97.3% and specificity of 98.92% in hemorrhage recognition by international standard data bank including normal and infected images.

2.14. Gaussian Filtering

V. Krishna Sree et al [17] proposed method computing the gradient of retinal image canny edge detector for detection of optic disk. Gaussian filtering removes background in first order. In the second order filtering, adoptive histogram equalization is used for contrast enhancement for the analysis disordering abnormalities in retinal image. Finally median filtering is used to reduce noise. The algorithm is tested on STARE database with the accuracy of 78.9%.

Aliaa Abdel-Haleim et al [18] surveyed to extract retinal vessels and to detect optic disc localization taken as input retinal images. An adoptive histogram equalization method which makes contrast equalization of images. 2D Gaussian match filter segmented the retinal vascular pattern and achieves 98.77% and 100% accuracy using STARE and DRIVE database respectively.

2.15. Thresholding Methods

Jaafar HF et al. [19] proposed a novel method for blood vessel detection and proposed to automatic detect of microaneurysms and hemorrhages from fundus photographs. A morphological technique used to segment red dots and blots from retinal structures then classifier separate real red lesions from images. The proposed method tested on standard database with sensitivity and specificity of 89.7% and 98.6% respectively.

2.16. Mathematical Morphology

Akara Sopharak et al [20] explored a process using mathematical morphology otsu algorithm for the automatic exudates detection of diabetic retinopathy and optic disk identification from non-dilated retinal images. Method has used median filter and CLAHE for contrast improvement. The non-dilated pupils reduce the examining time and the effect of the patient. Hard and soft exudates are detected using their color and sharpness of their borders.

A. Jain et al [21] proposed a robust and computationally efficient approach for the localization of the different features and lesions using different morphological operations applied appropriately in a fundus retinal image. An automated detection of microaneurysms lesions in retinal images can assist in early diagnosis and screening of a diabetic retinopathy. First detect the major blood vessels, find the approximate location of the optic disk using color properties. Wide assessment of the algorithm on 516 images for exudate detection with sensitivity and specificity of 95.7%and 94.2%respectively

2.17. Minimum Cross Entropy Threshold

Saumitra Kumar Kuri et al. [22] suggested a blood vessels extraction with a real time process using optimized matched filter with minimum cross entropy threshold. Minimum cross entropy threshold is effective in the threshold technique; it could be very time-consuming in normal or abnormal retinal image for vessels segmentation.

The performance of this proposed method was calculated on DRIVE database. This method computational time of whole MATLAB process was taken in a real time for each retinal image.

3. DISCUSSIONS

This article delivers the learning and analysis on the methods used for the detection of diabetic retinopathy with the help of morphological operations, template matching, median filtering, match filter, gabor filtering, region growing, thresholding, hybrid model etc. to discern the retinal abnormalities measure as an predictive, detection rate, accuracy, sensitivity and specificity with the publicly available international standard local clinical database.

Smart diabetic calculation method for diabetic retinopathy was using several techniques demonstrations in table 1, which can easily detect hard and soft exudates, blood vessels, macular region and fovea location considering region of interest of retinal fundus images. This several methods allows detecting the exudates and other abnormalities and with the classifying them as normal and abnormal images. Filtering and thresholding are the major part of detecting the abnormalities by reducing the background noises and by enhancing the contrast, eliminating poor quality features. Thresholding is works effectively in differentiating blobs, lesions with less time consumption. Edge sharpening, boundary correction are effectively done using filtering and thresholding. Discussed methods were tested on international standard database like DRIVE, MESSIDOR, DB0, DB1 and local hospital images.

Table 1: Comparison of Smart Diabetic Retinopathy Screening Systems on Various Methods

Author	Mode	Abnormality Detection	Benefit	Limitation	Parameter	Databank
H.AA.Nugroho et al[1]	Hessian matrix and CLAHE	MA	ROI based validation	Classification of images has not been performed	Sensitivity-91.06%, Specificity-99.97%,	Standard Database
J.Prakash Medhi et al.[2]	Morphological operation using color planes	Macula region	No need earlier knowledge of the spatial relationship of OD	Foveamust be tested with other defects	Accuracy- 98.21%	DRIVE DIARETDB0 DIARETDB1 LOCAL MESSIDOR
N. Sengar et al[3]	Region based	Grading of DME	To detect macula without dependency Of optic disc	Classification of hard exudates and reflection has not detection been executed	Accuracy -80 to 90%	MESSIDOR
A.Wasif Reza et al [4]	Maiden filtering and morphological reconstruction	Blood vessels	Time consuming	Effect of noise is more	True positive0.77	DRIVE
M. Kishore Dutta et al. [5]	Region based segmentation	Grading severity of NPDR	reducing the computation time significantly	Classification of images has not been performed	Accuracy-80%	–
Kuri et al.[6]	Local entropy thresholding with Gabor filter	Extraction of blood vessels	vessels extraction under normal or abnormal conditions	Cannot measure performance parameter	-	DRIVE
P.R.Patel et al.[7]	Morphological, Gabor filtering and Thresholding	Microanuerysms Hemorrhages Hard Exudates, CWS	Provides good detection even with abnormalities	Can increase the performance using addition of features	Sensitivity-92.41% Specificity-99.55% Accuracy-99.56%	DIARETDB0, DIARETDB1 MESSIDOR, Local Hospital
Geetharamani et al.[8]	Template matching and morphological proc.	Segment of optic disc region	Selection of scales improves result.	Scale selection scheme is not automatic	Accuracy-98.7%	Gold Standard
E. Grisan et al.[9]	Local thresholding	Hemorrhage lesions	False candidate rejection is good	No Multi level approach	Mean detection rate 94%	–
Subramanian. et al.[10]	Adaptive threshold and morphological operators	Executes and AMD	less color contrast images and Detection of low intensity	No special method for removing optic disc	–	DRIVE
A.Pachiyappan et al.[11]	morphological techniques	Macular irregularities	Accurate and reliable system	Not obtainable for rural areas	Accuracy-97.75%	–
M.D. Saleh et al.[12]	Thresholding and h-maxima transformation	Microanuerysms Hemorrhages	For refining the quality , Post processing is done	Verified with only low quality images	Sensitivity-84.47% Specificity-95.65%	98 Retinal images
M. Usmanet al[13]	Thresholding and transform	abnormal blood vessels and grading of PDR	Delivery of samples are overlaps	Tortuosity has not been comprised	High sensitivity	DIARETDB MESSIDOR
G.Singhet al. [14]	Gaborfilters and Hysteresis thresholding	Blood Vessels	Does not mandatorya supervised method	Manually selection of Thresholds level	Accuracy-93.1%	DRIVE
A.VidyaSagar et al.[15]	thresholding	Exudates	Robust and reliable	Estimate of DR has not been achieved with the changes	Predictivity-93% Sensitivity-99%	–
Priyakshi Bharali[16]	local thresholding	Blood vessel	Gives good detection even with abnormalities	Calculation of Severity of the abnormalities is not available	Specificity-98.92% Sensitivity-97.3%	HRFDIARETDB, MESSIDOR
V. Krishna Sree et al.[17]	Median filter	Optic disc	Robust and faster related degeneration	Not completed Severity grading	Accuracy-78.9%	STARE
A.A. Haleim et al.[18]	2D Gaussian Matched Filter	Retinal Vessels	improve performance by 2D vessel segmentation	Performance can be enhanced by post processing	Detection rate 98.77%	STARE
Jaafar HF et al [19]	Thresholding methods	Detection of hard exudates and grading	Promise for detection of red lesions	Verified with no standard database	Sensitivity-89.7% Specificity-98.6%	219 images
A. Sopharak et al.[20]	Mathematical morphology	Detection of Exudates	Exudates and macular gap available	small vessels separation is not possible	Sensitivity-80% Specificity-99.5%	–
A.Jain et al.[21]	Morphological operations	Microaneurysms (MAs).	Better edge resolution	Not confirmed on standard database	sensitivity and specificity of 95.7%and 94.2%	516 images with varied contrast, illumination and disease stages
S.Kumar et al.[22]	Minimum cross entropy threshold	Blood vessels	Separation of true vessel	Time consuming	Accuracy-96.1% Sensitivity-99.2%	DRIVE

4. CONCLUSIONS

This article offered the review and analysis of automatic diabetic assessment system for diabetic retinopathy using image examination through numerous image processing techniques like morphological operations, template matching, median filtering, match filter, gabor filtering, region growing, thresholding, hybrid model etc. This smart assessment system of image analysis decreases the complexities of the ophthalmologist to screen the impairment of vision loss at early stages. The detection rates of the abnormalities are confirmed through international standard databank.

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