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RECOGNITION OF DIABETIC RETINOPATHY USING BLOOD VESSELS FROM VIDEO SEQUENCES

[1]D.STALIN ALEX, [2] Dr.AMITABH WAHI, [3]Dr.J GEORGE CHELLIN CHANDRAN, [4]A.USHA RUBY, [5]Dr.R.REVATHI

[1]Research Scholar, Faculty of Information and Communication Engineering, Anna University, Chennai
[2]Professor, Department of Information Technology, Bannari Amman Institute of Technology, Sathiyamangalam
[3]Principal, CSI College of Engineering, Ketti, Tamilnadu
[4]Research Scholar, Department of Computer Science and Engineering, Bharath University, Chennai.
[5] Associate Professor, Department of Computer Science, SBG College, Trichy

E-mail: [1]drstalinalex@gmail.com, [2]awahi@rediffmail.com , [3]drstalinalex@gmail.com, [4]drstalinalex@gmail.com , s.revathisenatha@googlemail.com

ABSTRACT

Diabetic Retinopathy (DR) could be a condition occurring in persons with blood sugar, which causes progressive damage to the retina. At the beginning, Diabetic Retinopathy may cause no symptoms or mild vision problems. Eventually, however Diabetic Retinopathy can result in blindness. It is mainly due to the development of abnormal blood vessels in the retina. In this approach, we propose an efficient method to detect the blood vessels. The main focus of this paper is instead of using still images, the blood vessels are extracted from the video sequences. Contrast enhancement done in color image followed by thresholding, which helps in the dynamic preservation of the local contrast characteristics and median filtering carried in order to smoothen the background noise. The results of the proposed algorithm show a considerable improvement in the detection of blood vessels.

Keywords: *Diabetic Retinopathy (DR), Color Contrast Enhancement (CCE), Smoothening, Video Processing(VP),Object Extraction(OE).*

1. INTRODUCTION

Medical imaging is the technique and process used to create images of the human body or parts for clinical purposes or medical science. However imaging of removed organs and tissues is performed for medical issues, such methods are not usually referred to as medical imaging, but rather are a part of pathology Measurement and recording techniques that aren't primarily designed to provide pictures, like electroencephalography (EEG), magneto encephalography (MEG), electrocardiography (EKG), and others, however that produce information prone to be portrayed as a parameter graph vs time or maps that contain info regarding the measurement locations, can be thought-about as forms of medical imaging in a very limited.

In recent times, Sweden and other parts of the world have been faced with an increase in age and society related diseases like diabetes. According to recent survey [1], 4% of the country population has been diagnosed of diabetes disease alone and it have been recognize and accepted as one of the main cause of blindness in the country if not properly treated and managed. Early detection and diagnosis have been identified as one of the way to achieve a reduction in the percentage of visual impairment caused by diabetes with more emphasis on routine medical check which the use of special facilities for detection and monitoring of the said disease [1]. The effect of this on the medical personnel need not be over emphasized, it has lead to increase work load on the personnel and the facilities, increase in diabetes screening activities just to mention a few. A lot of approaches
have been suggested and identified as means of reducing the stress caused by this constant check up and screening related activities among which

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is the use medical digital image signal processing for diagnosis of diabetes related disease like diabeticretinopathy using images of the retina.

DR has mainly four stages:

A. Mild Non Proliferative diabetic Retinopathy

At this early stage, micro-aneurysms may occur. These manifestations of the disease are little areas of balloon-like swelling within the retina's small blood vessels. Approximately 40 percent of people with diabetes have at least mild signs of DR.

B. Moderate Non Proliferative diabetic Retinopathy

As the malady progresses, some blood vessels that nourish the membrane are blocked. Cotton wool spots and limited amount of bleeding can be seen. Generally 16 percent of patient with moderate NPDR will develop PDR within one year.

C. Severe Non Proliferative diabetic Retinopathy

Most blood vessels are blocked, depriving many areas of the retina with their blood offer. These areas of the retina are sending signals to the body to grow a fresh blood vessels for nourishment.

D. Proliferative Diabetic Retinopathy

PDR is the advanced form of the disease. At this stage, new fragile blood Vessels will begin to grow within the membrane and into the vitreous the gel like fluid that fills the within of the eye. By themselves, these blood vessels don't cause symptoms or vision loss. However, they need skinny, fragile walls. If they leak blood, severe vision loss and even visual impairment may end up.About 3 percent of people in this condition may suffer severe visual loss.

For doctors, it is more important to accurately detect and distinguish the blood leakages, haemorrhages and lesions from amongst the numerous blood vessels present in an eye. An important feature of this serious blinding disease is that, detectable changes takes place in the retina, which can be cured using laser treatment, if detected at an early stage. Detection of DR at a very initial stage helps to reduce the risk.

E. The eye structure

Eye is an organ associated with vision. It is housed in socket of bone called orbit and is protected from the external air by the eyelids[2]. The cross section of the eye is as shown in Figure 1.1 while that of retina is as shown in Figure 1.2 below Light enters the eye through the pupil and is focused on the retina. The lens assists in focusing images from different distance. The amount of light entering the eye is controlled by the iris when light is bright its closed, when light is dim its open. To the outside of the eye is a transparent white sheet called conjunctiva. Ciliary muscles in ciliary body control the focusing of lens automatically. Choroids form the vascular layer of the eye supplying to the eye structures. Through the optic nerve, the image which is formed by retina transmitted to brain. Optic disk is brighter than any part of the retina image and is normally circular is shape.

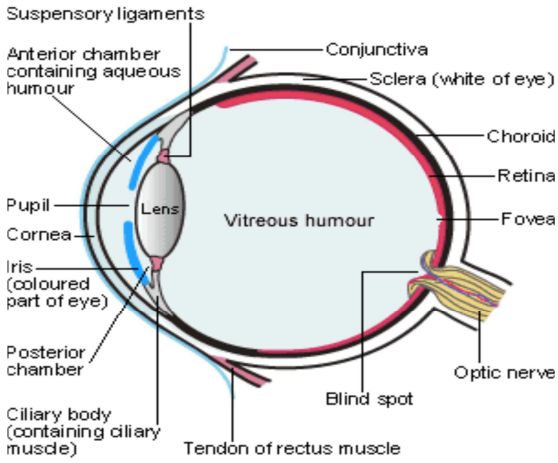

Figure 1.1 Structure of eye

It is also the entry and exist point for nerves entering and leaving the retina to and from the brain. Near to the centre of the retina is an oval shape object called macula. The fovea is near the centre of the macula and it contains packed cone cells. Due to high amount of light sensitive cells, the fovea is responsible for the most accurate vision[2] [3].

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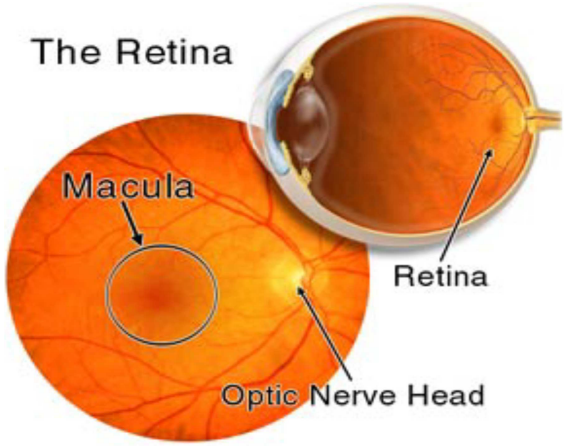

Figure: 1.2 Retina Image

The retina may be a multi-layered sensory tissue that lines the rear of the eye. It contains innumerable photoreceptors that capture lightweight rays and convert them into electrical impulses. These impulses move the nerves optics to the brain wherever they're become images. There are 2 sorts of photoreceptors within the retina: rods and cones. The retina contains more or less half dozen million cones. The cones are contained within the macula, the portion of the retina chargeable for visual modality. they're most densely packed inside the fovea centralise, the terribly centre portion of the macula. Cones operate best in bright light and permit us to understand colour.

F. Abnormalities Associated with the eye

Abnormalities associated with the eye can be divided into two main classes, the first being disease of the eye, such as cataract, conjunctivitis, blepharitis and glaucoma. The second group is categorized as life style related disease such as hypertension, arteriosclerosis and diabetes.

When the retina is been affected as a result of diabetes, this type of disease is called Diabetic Retinopathy (DR), if not properly treated it might eventually lead to loss of vision. Ophthalmologists have come to agree that early detection and treatment is the best treatment for this disease. DR occurrence have been generally categorise into three main form viz, BDR, PDR, SDR. These were explained in chapter one of this report. These Three classes can occur in any of the form described below as related to this research work.

Microaneurysms: These are the first clinical abnormality to be noticed in the eye. They may appear in isolation or in clusters as tiny, dark red spots or looking like tiny haemorrhages within the light sensitive retina. Their sizes ranges from 10-100 microns i.e. less than 1/12th the diameter of an average optics disc and are circular in shape, at this stage, the disease is not eye threatening.

Haemorrhages: Occurs in the deeper layers of the retina and are often called 'blot' haemorrhages because of their round shape.

Hard exudates: These are one in all the most characteristics of diabetic retinopathy and might vary in size from little specks to giant patches with clear edges. furthermore as blood, fluid that's made in fat and supermolecule is contained within the eye and this can be what leaks out to form the exudates. These will impair vision by preventing lightweight from reaching the retina.

Soft exudates: These are often called 'cotton wool spots' and are more often seen in advanced retinopathy.

Neovascularisation: This can be describe as abnormal growth of blood vessels in areas of the eye including the retina and is associated with vision loss. This occurs in response to ischemia, or diminished blood flow to ocular tissues. If these abnormal blood vessels grow round the pupil, glaucoma may end up from the increasing pressure inside the attention. These new blood vessels have weaker walls and will break and bleed, or cause connective tissue to grow that may pull the retina far away from the rear of the eye. Once the retina is force away it's referred to as a detachment of the retina and if left untreated, a detachment of the retina will cause severe vision loss, as well as cecity. Unseaworthy blood will cloud the vitreous and block the sunshine passing through the pupil to the retina, inflicting blurred and distorted pictures. in additional advanced proliferate retinopathy; diabetic fibrous or connective tissue will form on the retina.

2. LITERATURE REVIEW

A. Imaging methods:

The size and facts of our eye and retina are described in next section to understand intricacy of Imaging and the resolution of camera required to acquire the image. This will help us

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to visualize how the automated system developing is complicated and why so research goes on ,This will also allow us to understand how actually the retina construction it is and how the pathology development can affect the change in the size ,shape, thickness, and dimension of retina . Thus we therefore focus how the imaging systems of fundus, evolves to capture the various sections of retina and how it is complicated to develop to see all the parameters of retina in one image itself . Retinal images are acquired by a specialized camera called fundus camera. Mydriatic and non-mydriatic fundus cameras are used for retinal photography. The imaging modalaties are fundus film based photography, color fundus digital photography, stereo photography, hperspectral photography, Scanning laser opthalmoscopy, color Doppler imaging, computed tomography, ophthalmic ultrasound, retinal thickness analyzer and scanning laser polarimetry ,2D To 3D(by composing several axial scans and several OCT images) and now 4D and 5D just to see more and more details of retinaand understand the pathology more clearly. No single method of imaging captures all the features of retina .Table I shows the summary of imaging methods.

Table I

Sr No	Imaging Methods
1	Fundus photography
2	Color fundus photography
3	Stereo fundus photography
4	Scanning laser ophthalmoscopy (SLO)
5	Hyperspectral imaging
6	Adaptive optics SLO
7	Fluorescein angiography
8	Optical Coherence Tomography Imaging
9	Time-domain OCT, or time-of-flight OCT
10	Spectral-domain OCT
11	Three-Dimensional OCT Imaging
12	Longer Wavelength OCT Imaging

Table II

Here the table shows whether the video or still used for Diabetic Retinopathy detection.

SNO	YEAR	STILL/ VIDEO	METHOD
1[4]	2013	STILL	Laplacian of Gaussian
2[5]	2013	STILL	Splat Feature Classifiation
3[6]	2012	STILL	Sobel edge detection method in DIP
4[7]	2012	STILL	Red lesion Extraction
5[8]	2012	STILL	Optic Disk Localization
6[9]	2012	STILL	Radial Basic Function
7[10]	2012	STILL	Morphological Thresholding
8[11]	2012	STILL	Morphological Operation, Support Vector Machine(SVM) Classifier
9[12]	2012	STILL	Ensemble-based System
10[13]	2011	STILL	Gray-Level and Moment Invariants-Based Features
11[14]	2010	STILL	Radii method, Feature Extraction, Template Matching, MDD Classifiers
12[15]	2009	STILL	A Modified Matched Filter With Double-Sided Thresholding
13[16]	2004	STILL	Ridge-Based Vessel Segmentation
14[17]	1989	STILL	Two dimensional Matched filter
15[18]	2009	STILL	Ensemble Classification
16[19]	2013	STILL	Local Rotating Cross-Selection Profile Analysis
17[20]	2013	STILL	Hybrid Approach: Clustering, Mathematical Morphology
18[21]	2011	STILL	Contrast Limited Adaptive

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			Histogram Equalization
19[22]	2013	STILL	Candidate Extraction Algorithm
20[23]	2012	STILL	Curvelet Transform and Kirsch's Templates
21[24]	2007	STILL	Matched Filter
22[25]	2013	STILL	Ant Colony System
23[26]	2013	STILL	Image Subtraction, Thresholding, Intensity Conversion
24[27]	2006	STILL	Edge Detection. Morphological Processing

3. PROPOSED WORK

On consideration of the difficulties that ascend due to the direct application of typical expansion techniques to Diabetic Retinopathy, we propose to utilize color contrast enhancement technique. Fig.2 depicts the overall methodology in detection of blood vessels.

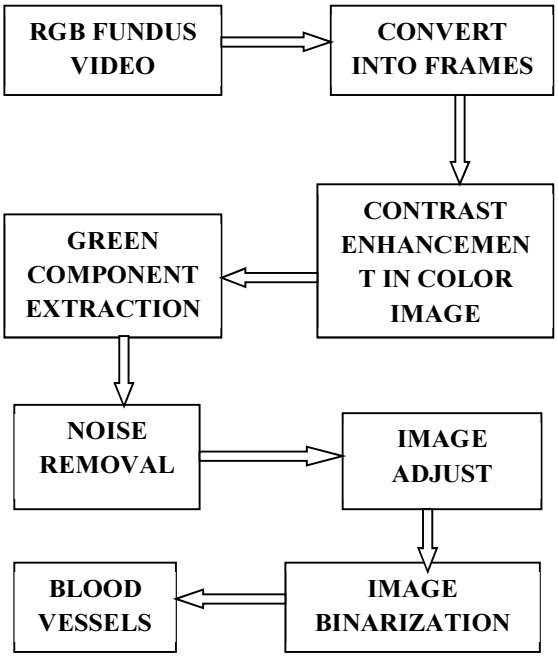

Figure 3.1 Proposed Work

The input videos are acquired from various DR databases. Blood vessels are extracted for the recognition of diabetic retinopathy. The contrast of the fundus image tends to be bright in the centre and diminish at the side, hence preprocessing is essential to minimize this effect and to have a more uniform image. The foremost step is to standardize the dimensions of the image. The input videos are in colored. The RGB fundus video is converted into frames for processing. RGB Frame operated through Color Contrast enhancement technique of histogram equalization. Each color component of the image is extracted to red, green, blue component. The green component is considered good for the detection of blood vessels. The values of green component are isolated from RGB fundus image. The frame is converted into a form of greyscales to filter out the noise in the image and to strengthen the appearance of blood vessels. This step enhances the contrast of the image and distinguishes the details of the vessel appearances. Finally the image segmentation is performed. The image is converted into a group of white and black pixels to extract the blood vessels from the image.

A. Histogram Equalization

The objective of the Histogram Equalisation scheme is to augment the overall contrast of the frame by gaining a uniform histogrammed edition of the color image. It attempts to balance the probability of occurrence of all the color values of the image. HE employs a monotonic, non-linear mapping that assigns a new intensity value to each of the pixels based on following computation: The probability density function of a digital image of „n" pixels with gray level range [0, L-1] is given by equation (1)

$$P(r_k) = \frac{nk}{n} \qquad (1)$$

Where $0 \leq rk \leq 1$ and $k = 0,1, \ldots, L-1$, and rk stands for the k^{th} rgb level, nk represents the number of pixels in the k^{th} level and n is the total pixel count. The transformation mapping of the gray level r_k to a new level s_k based on a cumulative distribution function is obtained using equation (2), which may be expressed as:

$S_k = T(r_k) = \sum_{j=0}^{k} \frac{nj}{n} = \sum_{j=0}^{k} P(rj)$ k0,1, ..., L – 1

(2) Where 'T' denotes the transformation function. Images acquired from fluorescence oscilloscope are often very low in contrast, which is evident from their histograms that are

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narrow and concentrated only to certain color level values. Retinopathy images contain minute details of the lesions and intra-retinal occlusions that get obscured due to limited contrast, and hence could not be presented easily before the doctors. This may lead to delayed diagnosis and wrong treatment. Histogram equalization plays an important role in several such cases, but leaves local changes in contrast unconsidered. CLAHE algorithm in color image considers the local variance of contrast and can successfully applied to DR imagery.

B. Contrast Enhancement in RGB frame

The Contrast Enhancement algorithm is defined to function adaptively on the image to be enhanced, unlike standard histogram equalization. It augments the contrast enhancement on local image data in a divide and conquer manner and hence efficiently tackles the global noise. In other words, the basic idea of the algorithm is to fragment the image into a number of small, non-overlapping contextual regions, called "Tiles". In the next step, the histogram equalization is applied to each of these regions. Thus, each tile is enhanced locally which is then followed by clipping and median filtering. A comparison of the contrast enhancement capability of the proposed scheme with that of HE, is also provided in the figure.

4. EXPERIMENTAL RESULT

Input:

Methodology used:

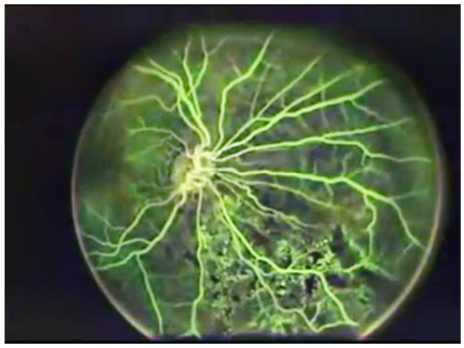

Figure: 4.1 Contrast Enhancement in Color Frame

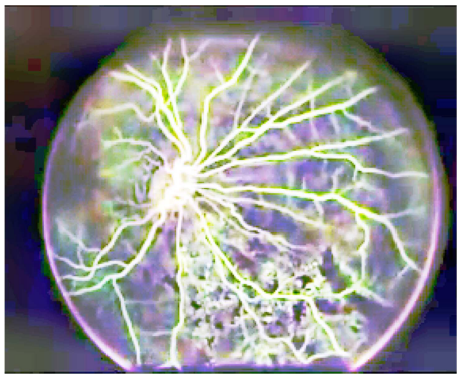

Figure 4.2: Histogram Equalization

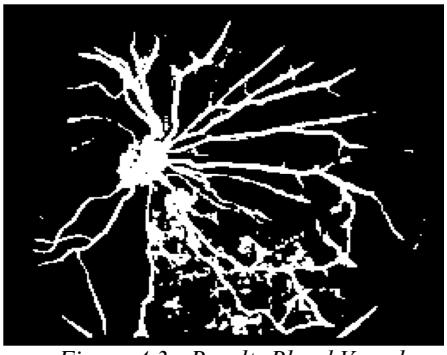

Figure 4.3: Result- Blood Vessels

5. CONCLUSION

In this paper, we explore Contrast Enhancement algorithm to transform DR image and modify its values in successive stages to separate blood vessels from fundus video. This work determines the presence of diabetic retinopathy by applying techniques on fundus videos taken by the use of fundus camera by a medical personnel in the hospital. We tested our technique on number of fundus videos. This method gives clearer and more accurate output for detecting blood vessels.

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