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Detecting Clinical Features of Diabetic Retinopathy using Image Processing

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***Abstract*— Today's lifestyle and food habits increase the risk of more people becoming diabetic at a very young age. Diabetic retinopathy is considered to be one of the most serious diseases among diabetic patients. Diabetic retinopathy occurs in the retina, which is the tissue responsible for vision in the eye. Detection of the disease at an early stage enables the patient to get treatment by advanced methods like laser treatment to prevent total blindness. The paper deals with detecting the diabetic retinopathy retinal changes. The retinal images are first subjected to pre-processing techniques like colour normalization and enhancement process. There may exist different kinds of lesions caused by diabetic retinopathy in a diabetic patient's eye such as micro aneurysm, hard exudates, soft exudates, hemorrhage etc. Automated analysis of the fundus (retinal image) image is very much essential and will be of help to facilitate the clinical diagnosis.**

Keywords—Diabetic retinopathy; exudates; hemorrhages; micro aneurysm.

I. INTRODUCTION

There are two reasons for the increased blood sugar in diabetic patients. In the first case the body does not produce enough insulin. In the second case the cells do not respond to the insulin that is produced. One of the major causes of blindness today is due to diabetes. When the small blood vessels in retina have a high level of glucose, the vision becomes blurred and can eventually result in total blindness. This is known as diabetic retinopathy. Regular screening and testing of the eye is essential in order to detect the early stages of diabetic related eye diseases for timely treatment, to prevent further loss in the eyesight. The project aims to detect the presences of changes in the retina such as the structure of blood vessels, micro aneurysms, exudates and hemorrhages using image processing techniques.

Diabetes is a metabolic disorder where the blood glucose level has increased [2]. Diabetic retinopathy, an eye disorder caused by diabetes, is the primary and major cause of blindness in America and over 99% countries. It is estimated to account for 12% of all the new cases of blindness in United States annually. It is estimated that about 10% of the population over the age of 40 are affected with diabetes and about 20% of this group will develop some form of diabetic complications in the eye. With the number rising every year, Singapore is one of the countries with the highest rate of diabetes in the world. There are two types of diabetes: [5] Type 1 is insulin dependent, while Type 2 is non-insulin dependent diabetes. Most of the diagnosed patients in Type 1 diabetes are children or young persons, but the disease may also occur in adulthood. Type 2 diabetes usually appears in the middle-aged or the elderly people, but now days it is also found among younger groups. The risk of developing diabetic retinopathy goes up with age and therefore middle aged patients and older diabetic patients are more prone to diabetic retinopathy.

Diabetic retinopathy occurs when blood vessels of the retina in the posterior part of the eye are damaged. Damages due to small vessels would be known as micro vascular disease while damages due to the arteries would be macro vascular disease. Generally, diabetic retinopathy is classified mainly as non proliferative diabetes retinopathy (NPDR) and proliferative diabetes retinopathy (PDR).The proposed system extracts the clinical features of diabetic retinopathy. The clinical features include blood vessels, exudates, micro aneurysms etc. This work is aimed to develop a system to analyze the retinal images for extracting important features of retinopathy using the image processing methods [2].

II.FEATURE EXTRACTION

There are several risk factors that make it more possible for a diabetic patient to develop diabetic retinopathy. The most important one is the duration of diabetes, since retinopathy does not appear suddenly, but it takes several years to develop. Almost all of Type 1 and about half of Type 2 diabetics have some degree of retinopathy when they have had diabetes for 20 years. Another risk factor is the high level of blood glucose, which harms the blood vessels of the retina and disturbs their activity. Other risk factors are high blood pressure, increased level of blood lipids, smoking, and pregnancy. The proposed system includes the feature selection of the retinal image by detecting the exudates (soft and hard), blood vessels, micro aneurysms, optic disc, and hemorrhages. The block diagram describing the proposed system is shown in figure 1.

A. Extraction of Blood Vessels

Examination of blood vessels in the eye allows the diagnosis of diabetic retinopathy. Blood vessels shape and size are considered as an indication to existence of diabetic retinopathy and its degree. The higher stage of the diabetic retinopathy is known to have more blood vessels due to eye

damages. The block diagram describing the extraction of blood vessel and other abnormalities that result due to diabetes is shown below.

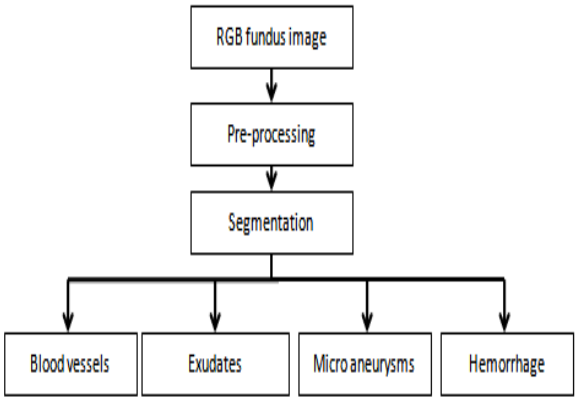

Figure 1 Block Diagram

The fundus image is first converted to gray scale image. The green channel component of the image is considered since the features appear to have maximum contrast in this channel. The kirsch algorithm is best used for finding the edge strength. The kirsch algorithm assigns an attribute for the best direction after going through the desired number of directions for every 45 degrees. The best direction is that corresponding to the largest edge strength [2]. A single mask that is considered is rotated to 8 compass directions: North, Northwest, West, Southwest, South, Southeast, East and Northeast. The edge direction is given by the mask that produces the maximum magnitude. The image is convolved with the eight impulse response arrays (HI-H8) and the gradient is computed. The scale factor is 15.

B. Detection of Exudates

Exudates are accumulations of lipid and protein that oozes out of blood vessels due to inflammation and are deposited in nearby tissues. They are typically bright, reflective, cream or white colored lesions seen on the retina. If this occurs on the macula of the eye, the vision may be lost. The exudates can be hard exudates (yellowish or white deposits with sharp margins) or cotton wool spots (soft exudates).

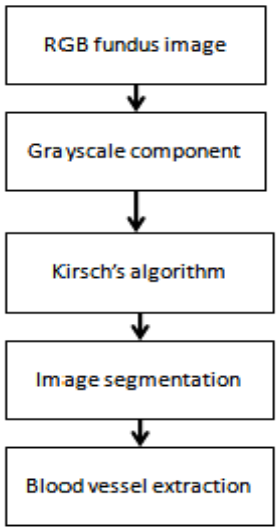

Figure 2 Extraction of Blood vessels

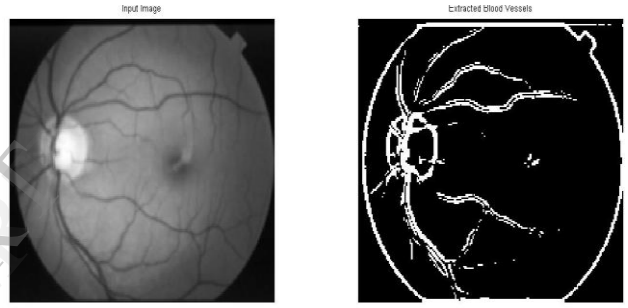

Figure 3 Extracted Blood vessels

Hard exudates are accumulated as a result of lipid formations that leak from the weakened vessels. Leisons due to hard exudates are yellow and waxy with somewhat clear edges.. Soft exudates, also called as cotton wool spots or micro-infarctions, appear when terminal retinal arterioles are obstructed. 'Cotton wool spots'(CWS), previously called soft exudates, are fluffy white lesions with blurry edges.[1]. They may appear when there are changes in glucose levels and also due to hypertension.

Optic Disc Detection

The optic nerve head or optic disc is the location where ganglion cell axons exit the eye to form the optic nerve. The optic disc is also called as the blind spot. It is called so because there are no receptors in this part of the retina. The optic disc detection is done by converting the image into gray scale and then filtered to remove larger gray level variations [7]. Then an opening operator is applied with structuring element disc. After this dilation operation is done on the image with the structuring element.

The detection of exudates is done through a series of processing steps [2]. The grayscale component of RGB fundus image is obtained. In order to eliminate the optic disc, the green component of the gray scale image is considered. Then histogram equalization is done to remove the blood vessels.

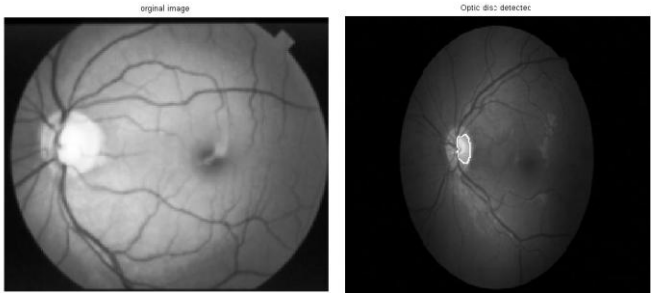

Figure 4 Optic Disc

The gray scale image also undergoes contrast enhancement process for the removal of darker features. The images are then multiplied or AND operated for the detection of exudates. The exudates are detected based on colour histogram thresholding. The color fundus image is split into a number of non-overlapping blocks. The color histogram is then calculated for each block of the image. By using suitable threshold values on colour histogram, exudates are detected over the colour fundus image. The extracted exudates are shown in figure.

C.Detection of Microanerysms

Micro aneurysms indicate the first sign of diabetic retinopathy. They appear as small red dots on the fundus image. More the number of dots, the disease may be severe. Micro aneurysms might be temporary or permanent changes; sometimes they might appear temporarily and then disappear. The block diagram for detecting micro aneurysms is as shown in figure 7.

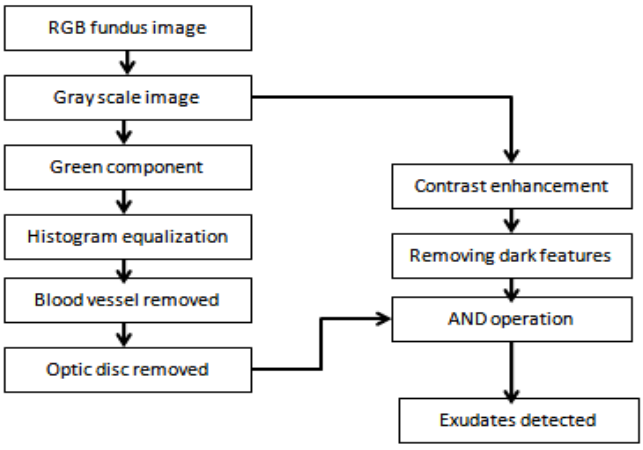

Figure 5 Detection of Exudates

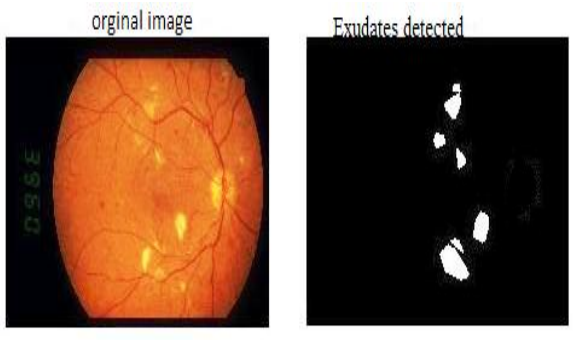

Figure 6 Extracted Exudates

The green channel of the image is chosen and converted to gray scale image. Normalisation is done by subtracting a background image from the gray image. Then median filtering is done using a (30 X 30) filter to the gray image and the resulting image is subtracted from the green image. Contrast enhancement is done using adaptive histogram equalization.

[8]To remove noise from the enhanced image the image is binarized by applying multi-level thresholding. The isolated patterns of micro aneurysms appear as circular dots of 10 to 100 microns diameter. The blood vessels form a larger connected component and can be differentiated from the micro aneurysms based on the area covered. The threshold value is decided based on experimentation. To remove the blood vessels, objects that have area greater than the threshold value are eliminated. The resulting image may include micro aneurysms.

D. Detection of Hemorrhages

A hemorrhage that occurs in retina is a disorder in which the bleeding occurs into retinal tissues on the background of eye. Hemorrhage is caused by hypertension, vein occlusion or diabetes mellitus [4]. There are mainly three types of hemorrhages like dot hemorrhage which is common in diabetic patients, flame hemorrhage and boat hemorrhage

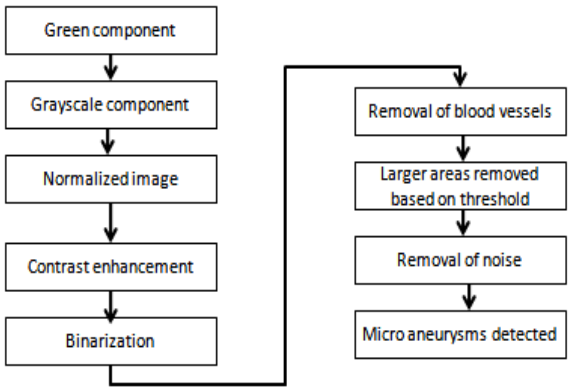

Figure 7 Detection of Micro aneurysms

Fundus image is obtained is first resized into true colour 576×768 at 24 bits, images. The resized image undergoes enhancement operation and median filtering is applied to reduce noise.

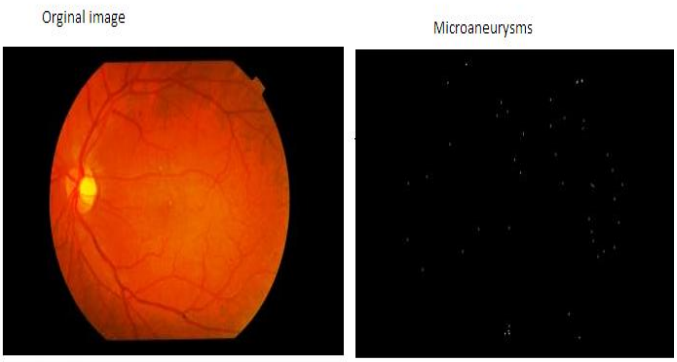

Figure 8 Micro aneurysms Detected

The enhanced colour image obtained is converted into grayscale. This gray image is subtracted from the median filtered image. By selecting a suitable threshold value, the image is binarized which contains only blood vessels and hemorrhages.

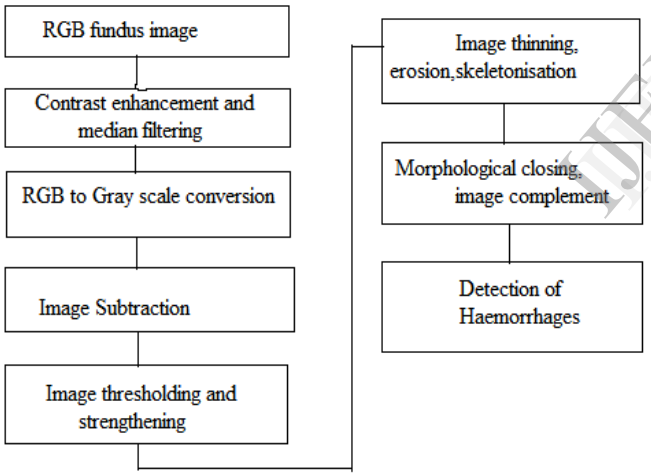

Figure 9 Detection of Hemorrhage

Then image strengthening is done. After the image undergoes thinning process and further erosion operation is done with disk structuring element of radius 6. With this process the blood vessels are thinned and skeletonization process suppresses the blood vessels. Then morphological operation is done to suppress blood vessels and for getting the actual size of hemorrhage. Then the complement of image is obtained and component labeling is done to find the area occupied by hemorrhage.

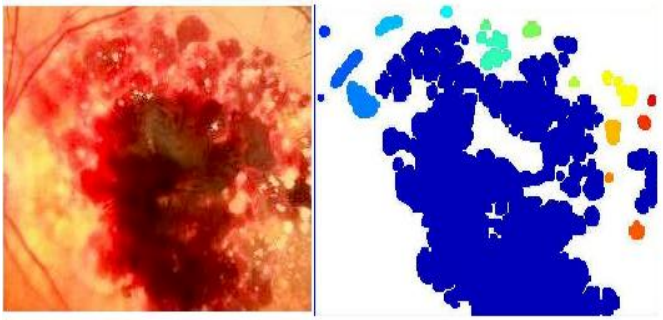

Figure 10 Hemorrhages Detected

III. CONCLUSION

Every year the vision loss due to diabetic related eye diseases are seen to increase. Nowadays the detection of the disease is done by a trained ophthalmologist. In this paper, the presences of abnormalities in the retina are detected using image processing techniques. The simulation is done in Matlab R2007b.As a future work the detection of retinal abnormalities due to diabetic retinopathy is done using fuzzy logic where the severity of the disease can also be indicated.

REFERENCES

[1] T.Vandarkuzhali, C.S.Ravichandran, D.Preethi,"Detection of Exudates Caused By Diabetic Retinopathy in Fundus Retinal Image Using Fuzzy K Means and Neural Network", IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 6, Issue 1 (May. - Jun. 2013)

[2] Kshetrimayum Lochan, Puspalata Sah and Kandarpa Kumar Sarma "Innovative Feature Set for Retinopathic Analysis of Diabetes and its Detection", International Journal of Computer Applications (0975 8887) Volume 83 No 7, 2012.

[3] SujithKumar S B, Vipula Singh,"Automatic Detection of Diabetic Retinopathy in Non-dilated RGB Retinal Fundus Images",International Journal of Computer Applications(0975 888) Volume 47 No.19, June 2012.

[4] Jitpakdee, Parisut, Pakinee Aimmanee, and Bunyarit Uyyanonvara "A survey on hemorrhage detection in diabetic retinopathy retinal images", 2012 9th International Conference on Electrical Engineering/Electronics Telecommunications and Information Technology, 2012.

[5] Prageeth, P.G, David J, and A Sukesh Kumar "Early detection of retinal nerve fiber layer defects using fundus image processing", 2011 IEEE Recent Advances in Intelligent Computational Systems, 2011.

[6] Sopharak, Akara, Bunyarit Uyyanonvara, and Sarah Barman. "Automatic Exudate Detection from Nondilated Diabetic Retinopathy Retinal Images Using Fuzzy C-means Clustering",Sensors, 2009.

[7] P. C. Siddalingaswamy. "Automated Detection of Optic Disc and Exudates in Retinal Images", IFMBE Proceedings, 2009

[8] Jagadish Nayak. "Automated Identification of Diabetic Retinopathy Stages Using Digital Fundus Images", Journal of Medical Systems, 04/2008

[9] www.ijestonline.com

[10] www.absoluteastronomy.com