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FUNDUS-FOVEA LOCALIZATION IMAGE ANALYSIS BASED ON AUTOMATIC SCREENING

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ABSTRACT

Fovea is one of the important features of a fundus image. Extract the different features like blood vessels, optic disk, and fovea are automatically from the retinal image is very difficult process. Fovea detection helps doctors to identify Diabetic Retinopathy (DR), Age Related Macular degeneration (AMD), Retinopathy of Pre-maturity (ROP) and some other diseases of the patients. Diabetic Retinopathy is a cause of sight loss sometimes it will reach an advanced stage and cannot be cure. However Retinal image is essential and crucial for the ophthalmologists to diagnosis the disease. In the RGB image the green channel exhibits the best contrast between the vessels and background. With the help of Adaptive Histogram Equalization, thresholding method and smoothening method, can detect the fovea region. Also the Automatic screening will help for the doctors to quickly identify the condition of patients. Here implemented a new efficient method to localize the fovea in retinal fundus image. In this proposed work aim for automatic screening of Fovea for detection of Diabetic Retinopathy. By automatically identifying the normal images, the workload and its costs will be reduced by increasing the effectiveness of the screening programs. Here collected the data base from LOTUS EYE HOSPITAL, Coimbatore. Based on that data base the work was done.

Keywords: fundus images, automatic screening, adaptive histogram equalization, fovea, diabetic retinopathy.

1. INTRODUCTION

Retinal image analysis is one of the crucial topics in medical image processing. During the last few centuries, people are trying to extract the various features like blood vessels, optic disk, macula, fovea are automatically from retinal image. Fovea is an important feature of a fundus image [1]. Diabetic Retinopathy (DR) is an eye disease that can lead to partial or even complete loss of visual capacity if left unanalyzed at the starting stages. Today Diabetic Retinopathy is the 3rd cause of blindness in India. To automatically detect diabetic retinopathy, a computer can interpret and analyze digital images of the retina.

The Fundus Image Analysis system described in this paper is developed to assist ophthalmologist's diagnosis by providing second opinion and also functions as an automatic tool for the mass screening of diabetic retinopathy. Color fundus images are used by ophthalmologists to study eye diseases like Diabetic Retinopathy(DR), Age related Macular Degeneration (AMD) and Retinopathy of pre-maturity (ROP). Extraction of the normal features like optic disk, fovea, blood vessels and abnormal features like exudates, cotton wool spots, Microaneurysms (MA) and hemorrhages from colour fundus images are used in fundus image analysis system for comprehensive analysis and grading of Diabetic Retinopathy (DR) [2].

Aim of the pre-processing is to attenuate the noise, to improve the contrast and to correct the non-uniform illumination. In the RGB image the green channel exhibits the best contrast between the vessels and background while the red and blue ones tend to be noisier. So green channel is used for further processing [2]. The next step is extracting features like blood vessels, optic disc, fovea region etc. [11] Adaptive Histogram Equalization is applied for contrast enhancement. A dark region includes vessels, exudates, noise etc. are dominant after contrast enhancement [11].

Blood vessels are one of the important structure in retinal images. It contains enough information for the localization of anchor points, maps the whole retina [11].

For the diagnosis of systemic diseases, examination of retinal blood vessels is important. It offers much information however for easy detection of exudates or microaneurysms [11]. Blood vessel segmentation is very difficult process they are segmented basically based on three approaches: thresholding method, tracking method and machine trained classifier [12]. Here we using threshold based blood vessel segmentation. It composed of matched filtering, entropy based thresholding, length filtering and vascular intersection detection.

To extract the features of optic disc, Morphological operation is applied to gray scale retinal image. From that binary retinal image is obtained. The fovea is responsible for sharp central vision (also called foveal vision), which is necessary in humans for reading, driving, and any activity where visual detail is of primary importance [11]. Fovea size is relatively small compared to the rest of retina, but the fovea is the only area of the retina where 20/20 vision is attainable, and very important for seeing fine detail and color[1],[11].

Usually this fovea zone is approximated to a circle of radius 200 micron [1]. The fundus images are most commonly used by ophthalmologists to monitor the progression of disease. They are captured using devices called ophthalmoscopes. Normally these images are manually graded by specially trained clinicians in a time consuming and resource intensive process [3]. Fovea is characterized by the center of the macula in retinal image. In fundus retinal image the macula is the darkest part approximately equal to a circle [3]. Geometrically fovea is at a distance of 2.5 times the diameter of the Optic Disk (OD) from its center region [1].

a) Diabetic retinopathy

Diabetic retinopathy is the prime cause of vision loss amongst the working age population of the developing and the developed countries. Diabetic patients are 25 times more probable to become blind than non-diabetic patients. Diabetic retinopathy is a complication of diabetes to the retina and to the blood vessels. Blood vessels are continuous patterns with little curvature, originated from optic disc and have a tree shape branching. The mean diameter of the vessels is about 100 μm, i.e. 1/40 of retina diameter. Optic disk or optic nerve head is the bright yellowish disk, from which, blood vessels and optic nerve fibers emerge. Optic disk transmits electrical impulses from the retina to the brain. It measures 1.5 to 2 mm in diameter. Macula is the central area of the retina, temporal to the optic disk. It is responsible to have fine central vision and colour vision. The center of macula is called fovea as shown in Figure-1. This region of the retina is the most sensitive region. The diameter of the macula is about 4 to 5 mm [2].

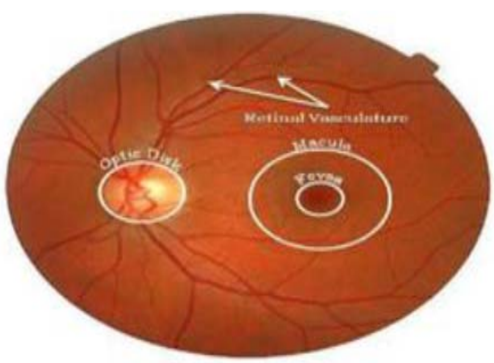

Figure-1. Human eye anatomy.

Diabetic retinopathy is caused by both the forms of diabetes i.e. diabetes mellitus and diabetes insipidus. It is a very asymptomatic disease in the early stages and it could lead to permanent vision loss if untreated for long time. The problem here is the patients may not know about it until it reaches advanced stages. Once it reaches advanced stages vision loss becomes inevitable [11]. As diabetic retinopathy is the third major cause of blindness particularly in India, there is an immediate requirement to develop efficient diagnosis method. The main stages of diabetic retinopathy are non-proliferative diabetic retinopathy (NPDR) and proliferative retinopathy (PDR) [2].

NPDR is the early stage of Diabetic retinopathy. Nonproliferative diabetic retinopathy (NPDR) is a microvascular complication of diabetes mellitus that can lead to irreversible visual loss [11]. In this case, at least one microaneurysm with or without the presence of retinal hemorrhages, hard exudates, cotton wool spots, or venous loops is present. 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 [2].

b) Problem formulation

- It is very difficult to detect fovea region because which have thin and complex structure, area of appearance is very small.
- Sometimes Computer Aided Diagnosis (CAD) Technique used for detecting diabetic retinopathy is leading in less accuracy result.
- There is a chance of reduction in image clarity.
- Major problem is time consuming.
- Prediction of blindness is difficult.
- Very difficult to identify eye diseases and abnormalities like:

1. Diabetic retinopathy.
2. Age related Macular Degeneration (AMD).
3. Retinopathy of Pre-maturity (ROP).
4. Exudates.
5. Microaneurosym.
6. Glaucoma.

2. METHEDOLOGY

a) Automatic detection of Fovea

Automatic detection of Diabetic Retinopathy (ADDR) is a fully automated system for detection of Diabetic Retinopathy (DR). Figure-2 shows the block diagram of ADDR. Input to this system is a fundus image which is part of human eye that can be seen through the pupil. Fundus image is the interior surface of the eye, opposite the lens, and includes the retina, optic disc, macula, Blood vessels and fovea. As the quality of the image is not satisfactory because of noise, bad contrast, uneven illumination etc. pre-processing is used to get better results.

The proposed method is made up of three fundamental parts, (1) pre-processing, which involves obtaining an gray image from green channel, background normalization, contrast enhancement and image binarization (2) feature extraction of the microaneurysms based on circularity, area and other features and (3) Classification based on count, thereby we can grade the severity [2]. The proposed method is made up of three fundamental parts. Basic system level block diagram is shown below:

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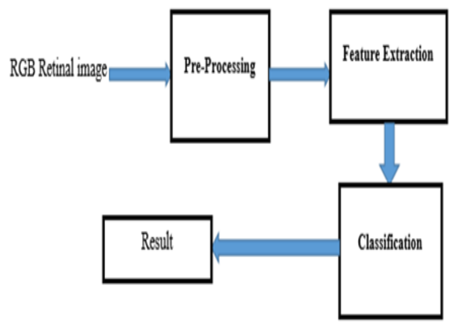

Fig 2: Basic system level block diagram

Figure-2. Basic blocks.

b) Pre-processing

It involves obtaining a gray image from green channel, background normalization, and contrast-enhancement and image binarization. The software stores those exams that, after analysis, appear to have no visible signs of the presence of diabetic retinopathy at some level of severity. The other exams, that possibly contain diabetic retinopathy related lesions or that have an image quality that prevents automated analysis are evaluated by a human expert. In this manner these automated systems can reduce the workload associated with large scale screening [10].

In the RGB image the green channel shows the best contrast between the vessels and background and is used for further processing. Then convert green channel image into a gray scale image because retinal blood vessels looks darker in gray image. Thus normalization and contrast enhancement is performed a well image quality. Normalization is performed by subtracting an approximate background from the gray image. A 30x30 median filter is applied to the gray image and the resulted image is subtracted plane to get normalized image. Adaptive Histogram Equalization is applied for contrast enhancement. A dark region including vessels, MAs, exudates and noise are dominant after contrast enhancement [2].

c) Feature extraction

Blood vessel segmentation, optic disc detection, fovea region. It enhancing the grey image, the uninformed illumination can be corrected and using the local transformation the contrast is increased [4]. The system is based on extraction of image ridges, which coincide approximately with vessel centerlines. The ridges are used to compose primitives in the form of line elements. With the line elements an image is partitioned into patches by assigning each image pixel to the closest line element [6]. The key idea is to enhance the relative contrast between the fovea and its surrounding such that it is well-separated in a retinal image [5]. Blood vessels segmentation blood of the retinal images allows early diagnosis of disease.

We propose to use a median filtering scheme to carry out demising of the image and thereby to find the fovea of the retina. For instance, popular convolution approaches suffer from variable retinal background and low contrast between vessels and surrounding pixels. Obtaining the center and surroundings of the optic disk, the diameter of the disk can be easily calculated. To localize the fovea region, we start with the image, containing only the blood vessels.

d) Classification

Based on the dark region and bright region we can classify the fovea, blood vessels and optic disc.

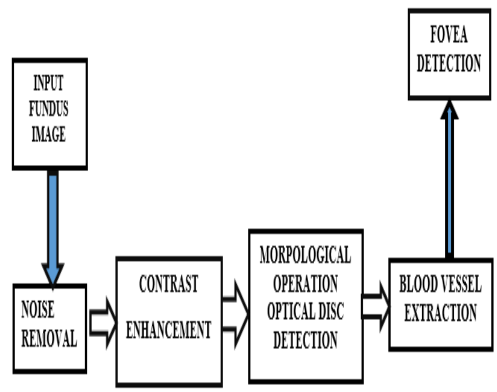

Fig 3: Overall Block Diagram for Detection of FOVEA

Figure-3. Detection of fovea.

e) Algorithm

Step-1: Giving RGB image (specimen) to the GDU.
Step-2: Smoothening the given specimen image as per our requirements.
Step-3: Obtaining green channel image from given specimen RGB.
Step-4: By using Adaptive histogram equalization method enhancing the specimen.
Step-5: Blood vessel segmentation has been take place here.
Step-6: Find optic disc from the difference between dark and brighter regions.
Step-7: Detect the fovea region.

3. RESULT AND DISCUSSIONS

For analysis of fovea region and Diabetic Retinopathy, the method is easily understood and used even by ophthalmologists and non- ophthalmologists. Here described a new efficient method to localize the fovea in retinal fundus image. Here used median filter, Adaptive Histogram Equalization, thresholding method, tracking method and machine trained classifier to localize the fovea region successfully. Proposed scheme is simple but efficient in extracting the fovea region.

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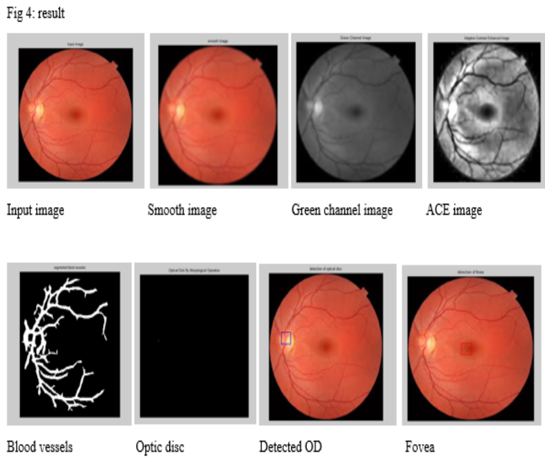

Figure-4. Simulation out puts.

The entire work is done with the help of MATLAB. Experiment shows that the outcome the scheme is comparable with others when applied on standard data set (images). This is clear in the simulation output shown in Figure-4. Moreover, it performs well on our own data set (images) consisting of images with variation. Thus, the proposed scheme is robust also. The extracted optic disc and fovea region may help in further diagnosis of related diseases like Diabetic Retinopathy, Age related macular degeneration (AMD), Retinopathy of pre-maturity (ROP) and some other diseases of the patients.

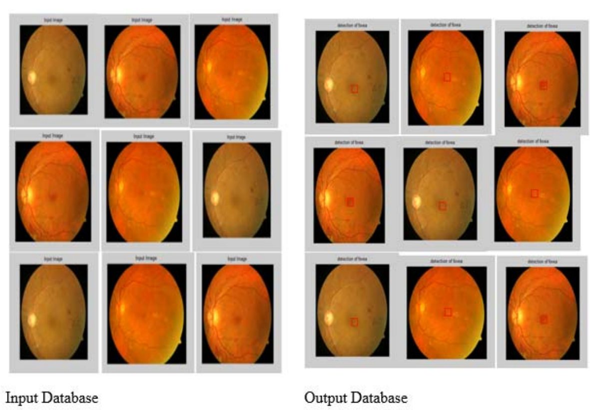

Figure-5. I/O data set.

Figure-5 shows the I/O data set. Which is used in experimental Moreover, it performs well on our own data set (images) consisting of images with variation. The input and output data base shows curresponding result.

a) Hospital survey

The data sets are collected from the LOTUS EYE HOSPITAL, Coimbatore. Going through a survey we can see the patients, their age, symptoms about Diabetic Retinopathy are analysed.

Table-1. Demographic data of diabetic retinopathic patients.

S. No	Name	Age	Sex	Duration	Symptoms
1	Manoharan	65	M	12	Headache
2	Moideen	45	M	10	Red vision
3	Murugeshan	26	M	3	Eye pain
4	Muthu samy	65	M	8	Blured vision
5	Palani samy	54	M	5	Loss in vision
6	Rajeswari	42	F	6	Loss day vision
7	Ramalingam	48	M	8	Loss in vision
8	Ravi	56	M	10	Gradual loss
9	Rukmani	55	F	16	Loss in vision
10	Saraswati	54	F	10	Blured vision
11	Shanmugam	74	M	14	Loss in vision
12	Shivasamy	72	M	15	Blured vision
13	Subhramanyam	74	M	16	Photophobia
14	Sulekha	36	F	8	Head ache
15	Sundaram	37	M	6	Red vision
16	Suseela	45	F	8	Eye pain
17	Thami selvi	45	F	9	Blured vision
18	Thanga raj	48	M	5	Loss in vision
19	Thanga samy	68	M	11	Loss day vision
20	Usharani	41	F	3	Loss in vision

Based on the analysis symptoms for Diabetic Retinopathy be detected. The major symptoms of Diabetic Retinopathy are:

1. Eye pain.
2. Blurred vision.
3. Decreased vision.
4. Loss day vision.
5. Decreased vision.
6. Gradual loss.

The Table-1 shows demographic data of Diabetic Retinopathic patients. The data collected from the hospital and the survey be prepared with the help of efficient and experienced doctors.

4. CONCLUSIONS

The methods to detect the fovea region of the eye, two major algorithms are considered in analyzing it. First algorithm involves the isolation of blood vessels and next algorithm deals with the localisation of fovea. This method is simple and efficient in extracting the fovea. In the proposed approach of blood vessel detection, morphological operations and geometrical functions are used to arrive the output.

In the second algorithm of fovea localisation, sliding window technique is utilized to find the gray mixed black colour fovea. The proposed approach is further enhanced to detect the diabetic retinopathy disease through feature extraction and principal component analysis method. It performs well on individuals own data set consisting of images with variation. This method is robust also.

This proposed methodology can be utilized in hospitals to detect diseases occurring on the eyes by doctors easily. Future scope of this project is to detect many eye diseases thus making mankind to be benefitted in large extent to be free from eye diseases leading to blindness with higher efficiency. From the results and its slotted out puts, clearly identify whole concepts about the whole work.

A hospital survey was conducted to accesses the pre valance of diabetic retinopathy and associated risk factors among diabetic retinopathy and associated risk factors among diabetic patients attending Lotus Eye Hospital, Coimbatore. From the hospital collected the fundus images and put them as the data base. While running the program successfully displayed the output of fovea region. The regular screening of the diabetic retinopathy is highly recommended as with the early detection of proliferative retinopathy and timely laser coagulation, which are known to prevent most of the diabetes-related blindness.

The data sets are collected from the LOTUS EYE HOSPITAL, Coimbatore. Going through a survey we can see the patients, their age, symptoms about Diabetic Retinopathy are analyzed. Based on the analysis major symptoms of Diabetic Retinopathy are:

1. Eye pain.
2. Blured vision.
3. Decreased vision.
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6. Gradual loss.

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