Retinal Efficiency on Detection of Isotropic Defect for Human Eye

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Abstract **- Image processing is one of the most rapidly emerging technologies in today's world. Now a day's it is used in every aspect of day to day life of a human being, it can be seen in almost every field in today's world, from traffic security system to industrial testing systems. In this paper the main focus is on one of the most essential and delicate part of human body i.e. EYES. The system which is intended to develop will be capable of detecting the problems which occurs to human eyes. It will provide great help to medical personals to detect the problems from which patient is suffering. The most widely used technique has been chosen to develop the system proposed in this paper i.e. image processing. Using this technique the system will process the image of the defective eye of any patient, which will be provided to it. The processed results of the image show the defects in the eye images.**
The images will be provided as input to the program to check the problem by mathematical and graphical methods, and to provide the area of defect in the patient's eye as the output. The program will be efficient in terms of time consumption as well as in terms of implementation, as the product will be economically cost efficient.

I. INTRODUCTION

Diabetic-related eye diseases are the most common cause of blindness in the world. For example, there are approximately 16 million Americans who have either Type I (juvenile onset) or Type II (adult onset) diabetes. All are at risk of developing sight-threatening eye diseases that are common complications of diabetes. In Singapore, more than half of all newly registered blindness is caused by retinal diseases, and diabetic retinopathy is one of the main contributors.

So far the most effective treatment for these eye diseases is early detection through regular screenings. During the screenings, color retinal images are obtained using fundus camera. However, this results in a large number of fundus images being produced that require manual analysis and diagnosis.[4] In other words, medical professionals have to spend a great deal of time and energy to review these photographs. It would be more cost effective if the initial task of analyzing the retinal photographs can be automated so that only the abnormal retinal images need to be reviewed by the medical professionals each year[2].

With this motivation in mind, a system has been developed to automate the preliminary analysis and diagnosis of retinal eye images. This system combines digital image processing and pattern recognition with machine learning techniques to analyse diabetic retinal images. Through this system, the retinal images will be classified into normal or abnormal ones. Fig. 1.1 shows an example of a healthy fundus image

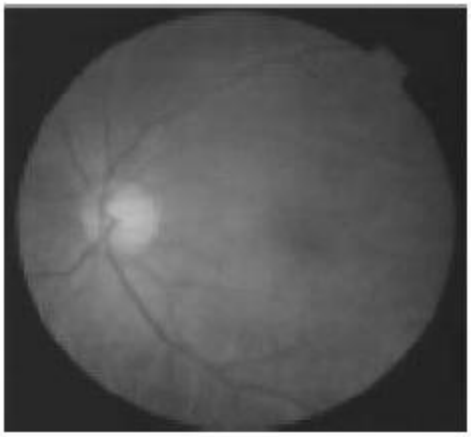


Figure 1.1 Healthy normal retina Eye

An unhealthy abnormal fundus images usually exhibit some abnormalities, one of which is the presence of exudates/lesions. Exudates/lesions are typically manifested as random whitish/yellowish patches of varying sizes, shapes and locations.[5] In this project, the main focus is how to detect the presence of retinal lesions accurately using a novel approach that combines brightness adjustment procedure with statistical classification method and ocal-feature-based verification strategy. Experiments have been carried out on 154 images (54 abnormal images, 100 normal images). The results indicate that this approach is able to achieve 100% accuracy in terms of identifying the all the retinal images with exudates while maintaining a 70% accuracy in correctly classifying the truly normal retinal images as normal.

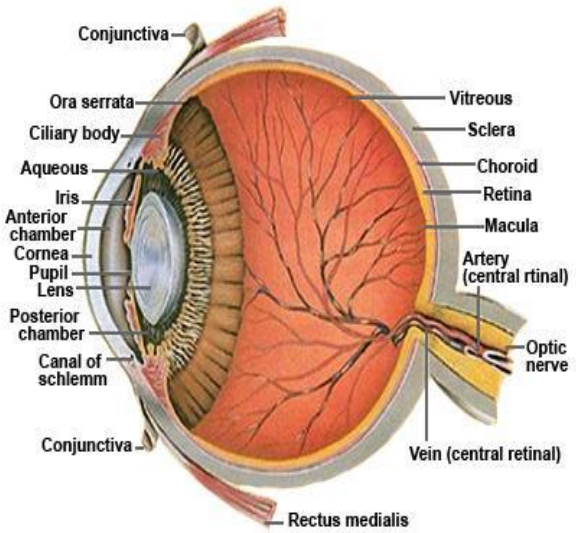


Figure 1.2 Overview of Eye Diagram

The eye is not properly a sphere, rather it is a fused two-piece unit. The smaller frontal unit, more curved, called the cornea is linked to the larger unit called the sclera. The corneal segment is typically about 8 mm (0.3 in) in radius. The sclerotic chamber constitutes the remaining five-sixths; its radius is typically about 12 mm. The cornea and sclera are connected by a ring called the limbus. The iris – the color of the eye – and its black center, the pupil, are seen instead of the cornea due to the cornea's transparency. To see inside the eye, an ophthalmoscope is needed, since light is not reflected out. The fundus (area opposite the pupil) shows the characteristic pale optic disk (papilla), where vessels entering the eye pass across and optic nerve fibers depart the globe. The retina has a static contrast ratio of around 100:1 (about 6.5 f-stops). As soon as the eye moves (sarccades) it re-adjusts its exposure both chemically and geometrically by adjusting the iris which regulates the size of the pupil. Initial dark adaptation takes place in approximately four seconds of profound, uninterrupted darkness; full adaptation through adjustments in retinal chemistry (the Purkinje effect) are mostly complete in thirty minutes. Hence, a dynamic contrast ratio of about 1,000,000:1 (about 20 f-stops) is possible. The process is nonlinear and multifaceted, so an interruption by light merely starts the adaptation process over again. Full adaptation is dependent on good blood flow; thus dark adaptation may be hampered by poor circulation, and vasoconstrictors like tobacco.


Figure 1.3 Bloodshot Eyeball

Eye irritation has been defined as ―the magnitude of any stinging, scratching, burning, or other irritating sensation from the eyel. It is a common problem experienced by people of all ages. Related eye symptoms and signs of irritation are e.g. discomfort, dryness, excess tearing, itching, grating, sandy sensation, smarting, ocular fatigue, pain, scratchiness, soreness, redness, swollen eyelids, and tiredness, etc. These eye symptoms are reported with intensities from severe to less severe. It has been suggested that these eye symptoms are related to different causal mechanisms. There are two major measures of eye irritation. One is blink frequency which can be observed by human behavior. The other measures are break up time, tear flow, hyperemia (redness, swelling), tear fluid cytology, and epithelial damage (vital stains) etc., which are human beings‘ physiological reactions. Blink frequency is defined as the number of blinks per minute and it is associated with eye irritation. Blink frequencies are individual with mean frequencies of < 2-3 to 20-30 blinks/minute, and they depend on environmental factors including the use of contact lenses. [7] Dehydration, mental activities, work conditions, room temperature, relative humidity, and illumination all influence blink frequency. Break-up time (BUT) is another major measure of eye irritation and tear film stability. It is defined as the time interval (in seconds) between blinking and rupture. But is considered to reflect the stability of the tear film as well. In normal persons, the break-up time exceeds the interval between blinks, and, therefore, the tear film is maintained. Studies have shown that blink frequency is correlated negatively with break-up time. This phenomenon indicates that perceived eye irritation is associated with an increase in blink frequency since the cornea and conjunctiva both have sensitive nerve endings that belong to the first trigeminal branch. Other evaluating methods, such as hyperemia, cytology etc. have increasingly been used to assess eye irritation.

II. PROBLEM IDENTIFICATION

The main objective is to simplify the above mentioned problems to much extent. The aim is to clearly detect the area of defect in the eyeball of the patient and show it in such a manner that it becomes easy for the patient as well as for the lay man to understand the problem, and to help the patient form getting freaked out even on the minor problems. Using this system anyone can be able to easily make out the seriousness of the problem system is only capable of analyzing the images fed into it and returns result as color image which is useful for medical personals, like doctors, to analyze the defect in the eye of the patient and come to a conclusion about the defected areas of the eyeball.

A. Ocular Fundus and Ocular Diseases

The retinal vessels constitute vascular network of human body that can be observed directly. The retinal image on the ocular fundus photograph can provide

information about pathological changes caused by some eye diseases such as glaucoma, which may lead to loss of vision. It can also indicate early signs of some systemic diseases, such as diabetes and hypertension. It is important to detect malign changes and abnormal structures of the retina as early as possible and monitor their progress during clinical therapy. Hence, the development of an automatic retinal image analysis system offers a potential of helping ophthalmologist diagnose retina related diseases, especially during mass screening.

B. Eye Structure and Ocular Fundus

The eye is often compared to a camera. Light comes in through the cornea, pupil, and lens at the front of the eye just as the lens of the camera lets in light to the film. This light is then focused on the inside wall of the eye called the retina (as on the film in a camera). This picture is then sent to the brain by the optic nerve, which connects the eye to the brain. When all of these parts of the eye and brain are working together, the image is perceived to be seen properly.

C. Ocular Fundus

The inner part of eye's posterior portion, including the optic disk, the fovea, the retina and the distributing blood vessels is called ocular fundus. The ocular fundus is the only part of human body through which the vascular network can be observed directly and non-invasively. The appearance of the ocular fundus can provide a lot of pathological information about eye diseases such as glaucoma, which may lead to loss of vision. It can also indicate early signs of some systematic diseases such as diabetes or hypertension. So the visualization and documentation of ocular fundus have been of great interest to doctors and scientists for many years.

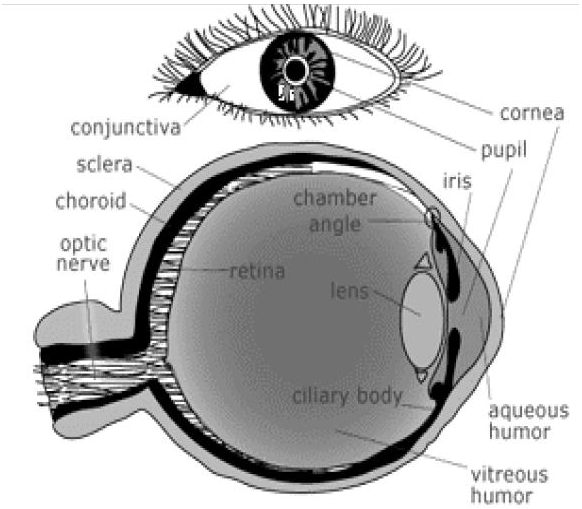


Figure 2.1 Eye Structure

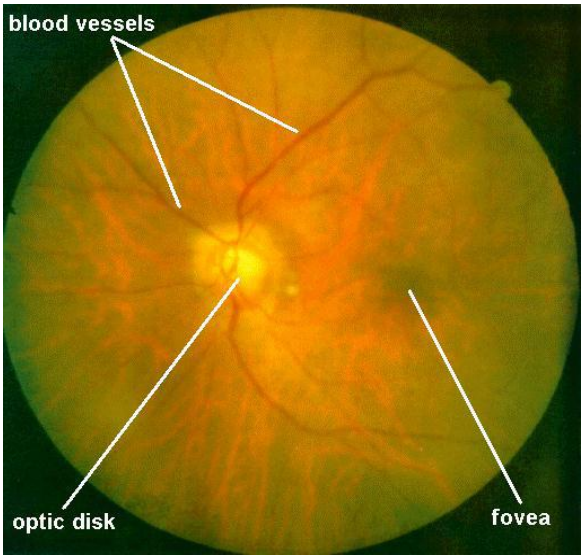


Figure 2.2 Normal Fundus

D. Eye Irritation

Eye irritation has been defined as ―the magnitude of any stinging, scratching, burning, or other irritating sensation from the eye‖. It is a common problem experienced by people of all ages. Related eye symptoms and signs of irritation are e.g. discomfort, dryness, excess tearing, itching, grating, sandy sensation, smarting, ocular fatigue, pain, scratchiness, soreness, redness, swollen eyelids, and tiredness, etc. These eye symptoms are reported with intensities from severe to less severe. It has been suggested that these eye symptoms are related to different causal mechanisms. There are two major measures of eye irritation. One is blink frequency which can be observed by human behavior. The other measures are break up time, tear flow, hyperemia (redness, swelling), tear fluid cytology, and epithelial damage (vital stains) etc., which are human beings‘ physiological reactions. Blink frequency is defined as the number of blinks per minute and it is associated with eye irritation. Blink frequencies are individual with mean frequencies of < 2-3 to 20-30 blinks/minute, and they depend on environmental factors including the use of contact lenses. Dehydration, mental activities, work conditions, room temperature, relative humidity, and illumination all influence blink frequency. Break-up time (BUT) is another major measure of eye irritation and tear film stability. It is defined as the time interval (in seconds) between blinking and rupture. But is considered to reflect the stability of the tear film as well. In normal persons, the break-up time exceeds the interval between blinks, and, therefore, the tear film is maintained. Studies have shown that blink frequency is correlated negatively with break-up time. This phenomenon indicates that perceived eye irritation is associated with an increase in blink frequency since the cornea and conjunctiva both have sensitive nerve endings that belong to the first trigeminal branch. Other evaluating methods, such as hyperemia, cytology etc. have increasingly been used to assess eye irritation.

E. Cataract

Cataract derives from the Latin cataracta meaning "waterfall". As rapidly running water turns white, the term may later have been used metaphorically to describe the similar appearance of mature ocular opacities. "descent of the water"- vulgarised into waterfall disease or cataract- believing such blindness to be caused by an outpouring of corrupt humor into the eye.
A cataract is a clouding that develops in the crystalline lens of the eye or in its envelope (lens capsule), varying in degree from slight to complete opacity and obstructing the passage of light. Early in the development of age-related cataract, the power of the lens may be increased, causing near-sightedness (myopia), and the gradual yellowing and opacification of the lens may reduce the perception of blue colors. Cataracts typically progress slowly to cause vision loss, and are potentially blinding if untreated. The condition usually affects both eyes, but almost always one eye is affected earlier than the other.

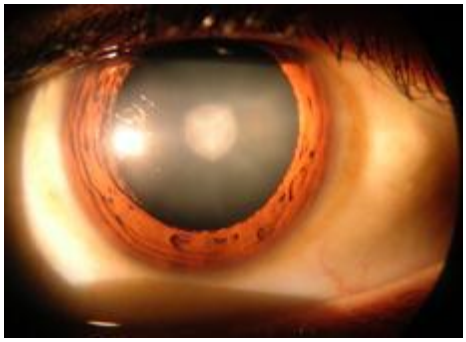


Figure 2.3 Magnified view of cataract in human eye, seen on the examination with a slit lamp using diffuse illumination

F. Technical Classification of fundus changes

Many retinal diseases and systematic diseases will lead to evident fundus changes which can be observed from fundus photographs. The most important and effective changes have been drawn out and technically reclassified

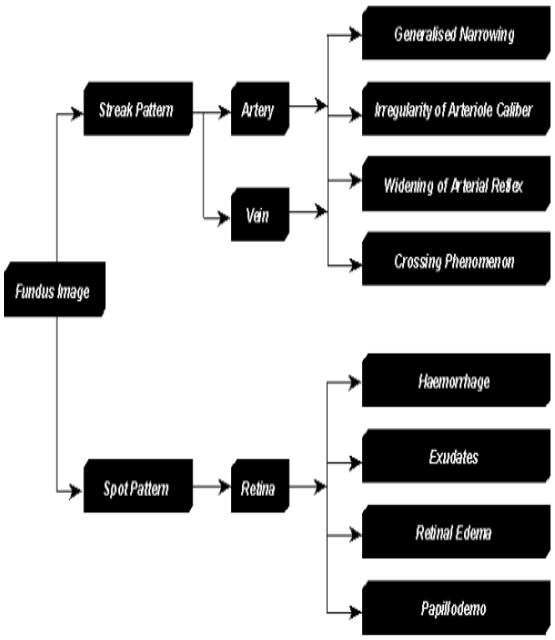


Figure 2.4 Technical Classification of fundus changes

Ocular diseases
A few of common eyes diseases are

Diabetic retinopathy : Damage to the retina due to the supplying blood vessel's diseases. ii.

Glaucoma : Increase in fluid pressure inside the eye that leads to optic nerve damage and loss of vision.

Cataract : Clouding of the eye's lens.

Types of Diabetic Retinopathy

- Non-proliferative (background)
- Proliferative

G. Detection and Treatment

Research has shown that severe visual loss from diabetic retinopathy can be prevented or delayed, but only if the retinopathy is diagnosed early enough. Non-proliferative diabetic retinopathy, need not any treatment except for regular exams. For macular edema or proliferative retinopathy need laser treatment to preserve the vision. Treatment with laser photocoagulation is aimed at sealing leaky vessels and preventing the growth of new, abnormal vessels. It doesn‘t cause pain because the retina does not contain nerve endings.Laser treatment has risks and side effects, which must be weighed against the benefits for each individual patient. In more advanced retinopathy, the benefits usually outweigh the risks.

H. Prevention

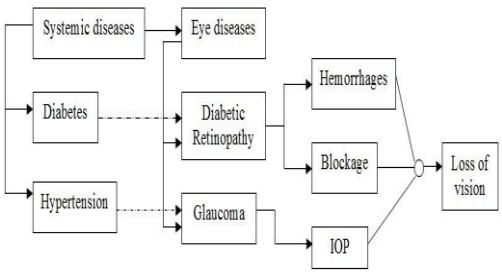
Although cataracts have no scientifically proven prevention, wearing ultraviolet-protecting sunglasses may slow the development of cataracts. It has been suggested that regular intake of antioxidants (such as vitamins A, C and E) is helpful, but taking them as a supplement has not been shown to have a benefit. Although statins are known for their ability to lower lipids, they are also believed to have antioxidant qualities. Oxidative stress is believed to play a role in the development of nuclear cataracts, which are the most common type of age-related cataracts. To explore the relationship between nuclear cataracts and statin use, a group of researchers treated a group of 1299 patients who were at risk of developing nuclear cataracts with statins. Their results suggest statin use in an at-risk population may be associated with a lower risk of developing nuclear cataract disease.

III. IMAGE SEGMENTATION AND PATTERN ClASSIFICATION

Segmentation is the initial stage for recognition, where by occurred image is broken up into meaningful regions are segments. The segmentation process is not primarily concern with, what region represents at only with a process of portioning the image. The simplest case, in binary images there are only two regions foreground background region. In gray-level images there will may be many types of regions are classes within in the image, for example natural scene to be segmented, there may be regions of sky clouds, ground, building and trees.

There are two approaches for image segmentation namely

- Thresholding
- Edge based methods.



Thresholding is method of producing regions of uniformity within an image based on some threshold criterion, T .The T can be defined as

T=T{x,y,A(x,y),f(x,y)}…… [4.1]
Where f(x,y) is the grey level of the pixel at (x,y) and A(x,y) denotes some local property in the neighborhood of this pixel.

A thresholded image g(x,y)= 1
If
$f(x, y) >= T$
0 if
$f(x, y) < T$

Thresholding techniques can be classified as Global Thresholding
Local Thresholding
Dynamic Thresholding

A. Edge based method

An edge is a place of local transition from one object to another. They aren‘t complete borders, just locally-identifiable probable transitions. Edge based operators are broadly classified as:

- Gradient Methods
- Morphological Methods

Edge detectors can be classified as:
- First order derivative Methods
- Second order derivative Methods

IV. PATTERN CLASSIFICATION

The classification sub-system is concerned with the process of pattern recognition or image classification .This process utilizes some or all of the object features or descriptors that have been extracted from the image to make an accurate decision as to which category of objects or prototypes the unknown object belongs. Various techniques exist for the classification, they are

- Statistical based Classification.
- Template Matching.

SBA **:**The statistical based classification relies on defining a set of decision rules based on standard statistical theory. A set of characteristic feature measurements are extracted from the input image data which are combined to define a feature vector identifying an object as belonging to one defined pattern class. The decision rules for this assignment are derived either from a priori knowledge of the expected distribution of the pattern or from knowledge of the expected distribution of the pattern classes or from knowledge acquired through a training process involving many initial measurements.

TMA **:** It is the simplest pattern classification approach. Here template is defined as an ideal representation object or pattern to be identified or classified within an image. The template process involves moving the template to every position in the image and evaluates degree of similarity, otherwise called as correlation value. Since correlation and convolution identical for symmetrical templates or windows, matching can be achieved using the

convolution operation. Sometimes it is also called as Matched Filtering. Consider the 3X3 template.

1	1	1
1	1	1
1	1	1

(a) Template

1	1	1	0	0
1	1	1	0	0
1	0	1	0	0
0	0	0	1	1
0	0	1	1	1

(b) Image array

8	5	3
5	4	3
3	4	5

Correlation array.

1	**1**	**1**	**0**	0
1	**1**	**1**	**0**	0
1	**0**	**1**	**0**	0
0	0	0	1	1
0	0	1	1	1

Second Template Position

A.Kirsch Template Matching

The Kirsch operator is one of first order derivative operator used for edge detection .For detecting edges it the operator rotated in all eight directions like East, West and etc.

5	-3	-3
5	0	-3
5	-3	-3

H1 East

-3	-3	5
-3	0	5
-3	-3	5

H2 West

-3	-3	-3
5	0	-3
5	5	-3

H3

-3	5	5
-3	0	5
-3	-3	-3

H4

-3	-3	-3
-3	0	-3
5	5	5

H5

5	5	5
-3	0	-3
-3	-3	-3

H6

-3	-3	-3
-3	0	5
-3	5	5

H7

5	5	-3
5	0	-3
-3	-3	-3

H8

Figure 4.1 Kirsch Templates Results

V.RESULTS

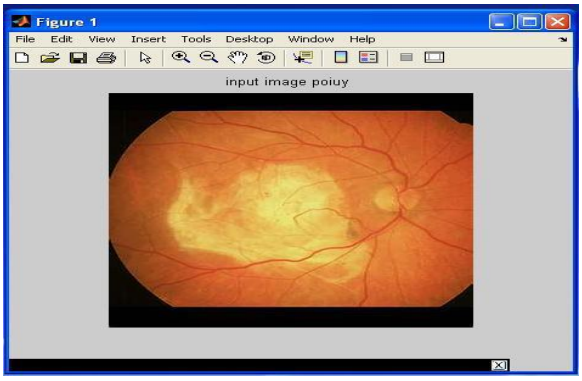


Figure 5.1 Input Image

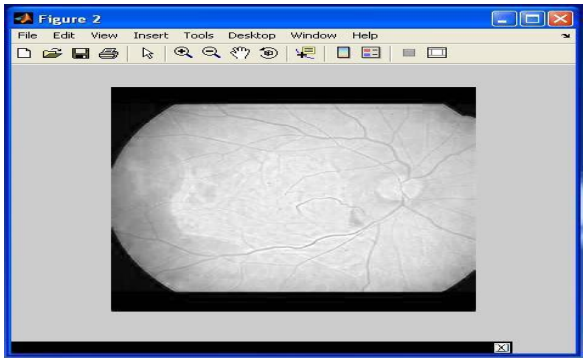


Figure 5.2 : Grey scale converted image

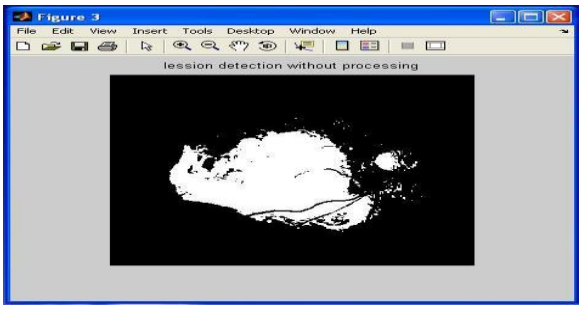


Figure 5.3 Filtered image of the eyeball

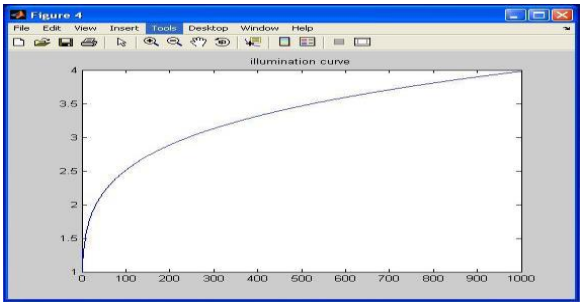


Figure 5.4 Illumination Curve

CONCLUSION

The automated method for detection of blood vessels and lesion in retinal images are presented in this project. Blood Vessels Detection using Two- Dimensional Kirsch filtering gives the complete and continuous vessel map of the blood vessels . On the basis of color information, the presence of lesions can be preliminarily detected by using MDD classifier based on statistical pattern recognition techniques. To deal with the problem of non-uniform illumination in the retinal images, an effective preprocessing Step, the brightness adjustment procedure, is proposed to ensure dim lesion patches that are scattered in darker background would not be missed and would not be regarded as background. Finally, a local window feature D is used to verify the classification result. With this, it can be seen that 100% accuracy in terms of identifying all the retinal images with lesions while maintaining a 70% accuracy in correctly classifying the truly normal retinal images as normal. This translates to a huge amount of savings in terms of the number of retinal images that need to be manually reviewed by the medical professionals each year.

FUTURE ENHANCEMENT

In future information about many other diseases like glaucoma can be gathered and that information can be used to train the software, to detect those diseases and provide proper information about the defected part of the eyeball. Since in the present system, images provided to the software are taken from fundus camera, hence using these images the software can be trained to detect the common existing problems in today‘s world, i.e. myopia and hyper metropia. These problems are commonly known as short sightedness and long sightedness respectively. These problems occur due to stiffness in lens of eyes. By training the software with the proper size, shape and working of lens, it can be detected whether the person is suffering from short sightedness or long sightedness.

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