



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 Issue: VI Month of publication: June 2016

DOI:

www.ijraset.com

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Lesions and Blood Vessel Detection in Eye Retinal Image

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Abstract— Medical image analysis, applied to clinical diagnosis in ophthalmology is currently drawing intense interest of scientists and physicians. It enables the physician to measure important structures in an image, compare sequential images, aggregate images similar in content and finally obtain automated diagnosis from images. This involves many challenging steps like image processing, segmentation, classification, registration, recognition of objects from arbitrary viewpoints and inferencing. Information about blood vessels in the eye can be used in grading disease severity or as a part of automated diagnosis of disease with ocular manifestations. Systemic or local ocular diseases, causes some measurable abnormalities in diameter, colour and tortuosity of the blood vessels in the retina. Disease like diabetes, as it progresses, generates new blood vessels (Neovascularization) in the retina causing loss of vision. This project work addresses issues in the development of automatic system for the analysis of retinal angiographic images, providing focus on the segmentation of the blood vessels and lesion detection. Kirsch Template Matching Algorithm is proposed for detecting the blood vessels in the retinal images and an effective approach to detect lesions in color retinal images. The proposed method uses two dimensional Kirsch Template Matching, which detect the blood vessel as the whole not only the edges and do the noise filtering in a single step and shows small vessels, capillaries to produce complete vessel map there by increasing the diagnostic ease of the ophthalmologist. The lesion detection algorithm, automatically take care of the non-uniform illumination using a power law transformation and classifies the lesion like regions in the retina image.

I. INTRODUCTION

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.

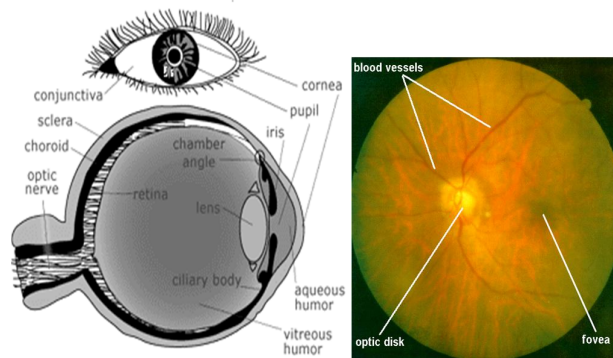
II. EYE STRUCTURE AND OCULAR FUNDUS

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.

III. 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. The normal and abnormal fundus are shown in Fig3.2.1 and Fig 3.2.2

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A. Techniques for Recording Ocular Fundus

Many techniques are being presently employed by the ophthalmologist to observe the ocular fundus and to obtain its morphologic information, such as

B. Ocular Fundus Photography

The prototype camera was fixed to the patient's head, and a 2.5-minute exposure was used. Although the set-up showed only the largest details of the retinal anatomy and pathology, it was revolutionary for allowing photographic documentation of retinal findings.

C. Fluorescein Angiography

Roentgen graphic examination of blood vessels after injection of a radiopaque contrast medium like fluorescein.

D. Indocyanine Green (Icg) Angiography

The infrared fluorescence of indocyanine green dye (ICG) highlights the circulation of the choroid providing enhanced view of the deeper vascular structures and provides images which are complementary to those produced by fluorescein.

E. Scanning Laser Ophthalmoscopy (SLO)

The Scanning Laser Ophthalmoscope (SLO) was invented by Webb, Pomeranzeff, and Hughes in 1979. It uses a very narrow moving beam of light which can bypass most ocular media opacities (ie. corneal scars, cataracts, vitreous hemorrhage) to reach the surface of the retina and record its surface detail. A live video image of the retina is displayed on a computer monitor and test results are digitally recorded. Several diagnostic test are possible with this machine.

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

G. Ocular Diseases

A few of common eyes diseases are

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

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 Diabetic Retinopathy

IV. DIABETIC RETINOPATHY

Diabetes is a disease in which the body does not produce or properly use insulin. Insulin is a hormone that is needed to convert sugar, starches and other food into energy needed for daily life. There are two major types of diabetes:

Type 1 - A disease in which the body does not produce any insulin, most often occurring in children and young adults. People with Type 1 diabetes must take daily insulin injections to stay alive. Type 1 diabetes accounts for 5 to 10 percent of diabetes.

Type 2 - A metabolic disorder resulting from the body's inability to make enough, or properly use insulin. It is the most common form of the disease. Type 2 diabetes accounts for 90 to 95 percent of diabetes. Type 2 diabetes is nearing epidemic proportions, due to an increased number of older populations, and a greater prevalence of obesity and sedentary lifestyles.

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V. TYPES OF DIABETIC RETINOPATHY

There are two main types of diabetic retinopathy:
non-proliferative (background) and
proliferative.

A. Non-Proliferative & Proliferative Retinopathy

High blood sugar can damage blood vessels in the retina, and when they are damaged, they can leak fluid or bleed (hemorrhage). This causes the retina to swell and form deposits. This is an early form of diabetic retinopathy called nonproliferative or background retinopathy. Vision is rarely affected during this stage of retinopathy.

Some patients develop a condition called macular edema. It occurs when the damaged blood vessels leak fluid and lipids onto the macula. The fluid makes the macula swell, blurring vision.

In a later stage, called proliferative retinopathy, new blood vessels grow on the surface of the retina. These new blood vessels can lead to serious vision problems because they can break and bleed into the vitreous, the clear, jelly-like substance that fills the center of the eye. Proliferative retinopathy is a much more serious form of the disease and can lead to blindness. If proliferative retinopathy is left untreated, about half of those who have it will become blind within five years.

The “danger Zones” in the eyes of a patient with diabetes are the retina and the vitreous humor. The retina contains one of the most complex networks of blood vessels and capillaries in the body. When these blood vessels and capillaries in the body. When these blood vessels are weakened by high blood sugar the retinal tissue cannot function. The vessels can leak clear fluid and cause swelling or they may break and cause bleeding into the surrounding retina or into the vitreous humor. Blood in the vitreous blocks light and causes a sudden loss of vision. This is called a vitreous hemorrhage.

Diabetes can cause double vision when it affects the nerves that control the alignment and movement of the eyes. It can also cause the optic nerve to be more easily damaged by glaucoma. Retinopathy is present in 90% of those who have had the disease for more than 20 years.

VI. GLAUCOMA

Glaucoma accounts for 20% of blindness in Singapore. It is a condition in which there is raised pressure within the eyeball leading to irreversible damage to the optic nerve. The optic nerve is responsible for sending messages from the eye to the brain and so enabling us to see. It is sensitive to increase in IntraOcular Pressure (IOP) associated with glaucoma: as the IOP increases, nerve cells at the optic nerve head are killed and the patient eventually notices a loss of sight, unless the IOP is reduced surgically or by medication. The detection and diagnosis are based on the measurement of the IOP and the changes in the shape, volume and depth of the optic nerve head and the neuroretinal rim area. Glaucoma may be treated with medications, laser, or other forms of surgery.

VII. CATARACT

A cataract is a clouding of the normally clear and transparent lens of the eye. It is most commonly the result of aging, but there are other factors which can accelerate the formation of a cataract, such as diabetes and eye injuries. Cataracts cause gradual and painless blurring of vision, so it is important to have an eye examination to determine the cause of the patient's poor vision. The treatment of the cataract is to remove the cataract and replace with an artificial lens by surgery.

VIII. 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. Treatment with laser photocoagulation is aimed at sealing leaky vessels and preventing the growth of new, abnormal vessels. It does

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. 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. From above study the Optical System of the eye permits direct observation of retinal blood vessels including some capillaries. Blood vessels can act as landmark for localizing the Optic nerve, Fovea and lesions. As a result of Systemic or local ocular disease, the blood vessels can have measurable abnormalities in diameter, colour and tortuosity. For example diabetes can generate new vessels (Neovascularization). Information about blood vessels can be used in grading or as part of the process of automated diagnosis of disease with ocular manifestations.

IX. 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

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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, we are able to achieve 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.

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