A Graph Based Segmentation for Extraction of Blood Vessels in Retinal Images

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Abstract

Nowadays, examine the retinal blood vessels can provide very helpful information to doctors for detecting the early stages of diseases such as hypertension, cardio-vascular, diabetic retinopathy etc. The retinal blood vessels of thinner veins and thicker arteries are affected by those diseases and there is a development of a computer-assisted diagnostic system for glaucoma in retinal images. Retinal vessels can be affected by many diseases. In diabetic retinopathy conditions, the blood vessels often show abnormalities at early stages. In the existing system, the Vessel Segmentation Algorithm is used. Blood vessels can be seen as thin elongated structures in the retina, with variation in width and length. This study has implemented a pre-processing technique that consists of effective adaptive histogram equalization and robust distance transform to segment the blood vessel from the fundus retinal image. It improves the robustness and the accuracy of the graph cut algorithm. To overcome this problem Exudates Segmentation is proposed. Exudates are nothing but segmentation of retinal diseases by using the segmented structures of the retina (blood vessels and optic disc).

Index Terms: Retinal images, vessel segmentation, blood vessels, exudates segmentation, disease segmentation.
1. Introduction

The retina is important in the part of the eye; the retina is commonly visible as a light sensitive tissue lining in the back of our eye. Light rays are focused onto the retina through our cornea, pupil, and lens. Most of the eye problems are caused in retina such as glaucoma. Due to that glaucoma short sight, long sight problems occur. To detect the retinal diseases exudates segmentation algorithm is used. Exudates are nothing but segment the retinal images and enlarge that to detect the retinal diseases. The paper [1] has been presented two main mechanisms such as robust methodology for the detection of an optic disc and boundary segmentation, which develop the computer-assisted diagnostic system for glaucoma in retinal images. This paper [5] presents an automated system to locate an optical disc and its center in all types of retinal images. The ensemble of steps based on different criteria produces more accurate results. Exudates Segmentation algorithm easily identifies the diseases and helps the doctor to cure the diseases. It gives more helpful information to detect the diseases. Initially, the retinal images are converted to gray images that are black & white images and then enlarge that image to detect the disease using exudates algorithm

**Basic Form of Image Processing**

Digital image processing is one of the methods using computer algorithms to perform an image processing technique on digital images. Image processing can also be used in mathematical operations with the help of any formations of signal processing that is the input of an image may be considered as a series of an image or a video type, it may either be photographs or video frames. Similarly, the outcome of image processing may be either an image or group of characters or any types of parameters which may relate to an input image. In Image processing techniques images are mostly treated as a two-dimensional signal and standard signal processing techniques will be applied. At the same time, images may also treat as three-dimensional signals for the third dimensions will proceed as time or Z-axis. Optical and analog image processing are mostly processed in this technique. This article is basically about the general techniques which may apply all over to them. In computer vision, the images may consider as a high-level image processing which machine may be a computer/software will decipher the physical models of images or a sequence of images that is either be a video or 3D full body magnetic resonance scans.

Image processing techniques are much advanced and gained broader scopes due to the importance of scientific visualization in this modern science and technologies. It also often used in large-scale complex scientific/experimental data. For example, in genetic researchers, it may include a microarray data or multi-assist portfolio trading in finance in real time process. It also contains many methods such as Image Enhancement, Image Restoration, and Image Compression. Each method has its own functions to improve the technologies in image processing.
2. Related Works

Detection of Blood Vessels


3. Segmentation and Detection

Vessel Segmentation

The problems of detection of papilla region and vessel detection on images of the retina can be solved by pattern recognition techniques. HRT device, as well as fundus images, can be used as a source for the detection in the Topographic images. It is to separate vessels inside the papilla area from those outside this area. The common retinal image and the detection of blood vessel segmentation are shown in Figure 1. Therefore, for vessel segmentation detection of papilla region is also important. In this contribution, this study present state of the art methods for automatic disk segmentation and compare their results. Using morphology vessels detected with matched filters (wavelets, derivatives of the Gaussian, etc.) as well as vessel segmentation is shown. In worldwide Glaucoma is the second most common cause of blindness. The effects of glaucoma damage the optic nerves and its diagnosis by analysis of retinal images. If the damages of optic nerves are not detected in the early stage it will lead to blindness. For diagnostic purposes, automatic vessel segmentation in retinal images is crucial. The vessels can be detected in either reflectivity images (fundus images) or in tomography images (e.g. images, to either reflectivity or topography image). The area inside and outside of optic disk vessel structure needs to be described separately to increase the diagnostic expression. Vessels in the retina should be analyzed for the papilla region and for the rest of the retina. Several methods for vessel segmentation are listed which were originally applied to X-ray images, some of the eye images.

Figure 1: Color Retinal Image and Vessel Segmented Image
Exudates Segmentation

Retinopathy is a disease showing no physical signs of occurrence with the major repercussion of loss of vision. The retinopathy cases require evaluation of innumerable database which is increasing with each year. There is various automated evolution to follow up the retinal diseases. In this paper, a simpler automated approach is presented to detect diabetic retinopathy taking exudates into account. The direct segmentation, which generated mediocre results which texture of unhealthy areas, is dissimilar. Therefore a different method is developed for use the homogeneity of healthy areas rather than unhealthy areas. In this method, this study first extracts the healthy areas such as blood vessels, by entropy thresholding method and optic disc using Sobel filter method. Then the thresholding method is employed to segment the exudates in diabetic retinopathy images. Various qualities of retinal images are used and the results clearly show that the presented method performs better than the previously proposed methods for segmentation of exudates.

Exudates Detection

Basic steps involved in our automatic segmentation method for detecting exudates are as following:

- Extracting green component in the retinal image
- Extracting vessels and eliminating them
- Detection of OD and eliminating the OD area
- Updating the exudates in the image
- Evaluating the results

The processing method of Exudates Detection follows as Figure 2.

4. Research Method

Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) is a computer image processing technique helps to improve contrast in images. This equalization differs while comparing other ordinary histogram equalization. This equalization computes
several types of histograms each corresponding to a distinct section of the image and the main use of this process is to redistribute the lightness values of the image. So it is suitable for enhancing the definitions of edges and improving the local contrast in each region of an image.  

**Efficiency of AHE**

Ordinary histogram equalization uses the same transformation which is derived from the histogram image to transform all pixels. When the distribution of pixel values is similar throughout the image it works well. However, when the image contains regions that are significantly lighter or darker than most of the image, the contrast in those regions will not be sufficiently enhanced. Adaptive histogram equalization (AHE) improves on this by transforming each pixel with a transformation function derived from a neighborhood region. The derivation of the histogram transformation functions is exactly the same as for ordinary histogram equalization. The transformation function is proportional to the cumulative distribution function (CDF) of neighborhood pixel values.  

**Robust Distance Transform**

In computer vision, image processing and pattern recognition distance transforms are an important tool. A distance transform of a binary image specifies the distance from each pixel to the nearest non-zero pixel. Distance transforms play a vital role in the binary images comparison particularly for images. And it results from local feature detection techniques that are corner or edge detection.

**5. Proposed Work**

In the proposed method a reliable and efficient method is used for detecting the blood vessels in retinal images. In existing vessel segmentation technique helps to detect the blood vessels by using some general image processing techniques. In this paper, the exudates segmentation is introduced to detect the blood vessels in the advanced method by using image processing techniques.  

**Architecture**

The architecture process is as follows:

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Input Retinal Image → Pre-Processing → Segmentation
                     ↓                    ↓
                     Exudates            Classification
                     ↑                    ↑
Non Exudates → Features Extraction
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**Algorithm for Proposed Work**

The algorithm step follows the basic work of detecting blood vessels in retinal images using exudates segmentation and the extraction of green channel in retinal image follows as Figure 3.
1. Start the Program
2. Insert the input image to detect the retinal disease
3. It extracts the green component from the image.
4. After extraction, it eliminates the blood vessels.
5. It detects the optic disc and eliminates.
6. After that exudates are detected in the image
7. Final Output
8. Stop the Program

Figure 3: Extraction of Green Component in Retinal Image

6. Results and Discussions

The Exudates Segmentations system detects and grades the severity of diabetic retinopathy, macular edema. It is consistently irrespective of color variations, illumination levels and the amount of noise. Hence, this system can also function as an automatic tool for the mass screening of diabetic retinopathy. To evaluate the proposed Exudates Segmentation system performance a dataset of 1540 images is used. The Exudates Segmentation system detected diabetic retinopathy with a high sensitivity and specificity of 100% and 96.98% respectively when it compared to other diabetic retinopathy screening systems.

The other features of the Exudates Segmentation system are: It grades diabetic retinopathy, macular edema and gives the exudates location and area which are not in the existing diabetic retinopathy screening systems.

7. Future Work

The Exudates Segmentation system developed in this thesis can be implemented on an embedded processor mounted on the fundus camera itself. This process will directly indicate the severity of the disease in real time. So the patients, whose are affected with advanced diabetic retinopathy can be urgently directed to the nearby health centers. The inbuilt processor removes the need for trained technician near the screening site by the fundus camera itself. The Embedded processors have some limited computational powers. So computationally, the
simple detection algorithms such as based on the KNN (K-Nearest Neighbor) and SVM (Support Vector Machines) classifiers can be loaded into the detecting algorithms. Thus the process requires coding methods in assembly languages. Even though the target of our Exudates Segmentation system, which is presented in this thesis, is going to detect the retinopathy diseases caused by the metabolic Syndrome. In the future process, this system may also be extended to detect other diseases, which may affect in retinal images. The SWFCM (Spatially Weighted Fuzzy C-Means) clustering based bright lesion detection method is one of the advanced methods is presented and can be used to detect some diseases like Age-related Macular Degeneration etc, which may be the leading cause of central vision loss in people over the age of fifty years. Thus this paper can be applied in other medical image analysis application to detect various types of diseases in the retina.

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